ENTRY No. 30

NAME OF MACHINE Karlsruhe Isochronous Cyclotr. DATE 8/1/81
INSTITUTION Kernforschungszentrum Karlsruhe, Zyklotronlaboratorium
ADDRESS D-7500 Karlsruhe, Postfach 3640 (West Germany)
TEL 07247-822433 TELEX 7826484
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
COST, ACCELERATOR 4.6×10^6 DM
COST, FACILITY, total 20×10^6 DM
FUNDED BY Federal Government & State of B.-Württemberg

ACCELERATOR STAFF, OPERATION AND DEVELOPMENT
SCIENTISTS 5 ENGINEERS 5
TECHNICIANS 10 CRAFTS 20
GRAD STUDENTS involved during year
OPERATED BY - Research staff or 10 Operators
OPERATION 168 hr/wk, On target 135 hr/wk
TIME DISTR. in house + 50 %, Outside 50 %
BUDGET, op & dev 2×10^6 DM
FUNDED BY Federal Government & State of B.-Württemberg

RESEARCH STAFF, not included above
USERS, in house 40 outside 90
GRAD STUDENTS involved during year
RESEARCH BUDGET, in house
FUNDED BY

MAGNET
POLE FACE, diameter (compact) 225 cm, R extraction 105 cm
R injection cm
GAP, min 8 cm, Field 19.5 kG
max 16 cm, Field 9.5 kG
AVERAGE FIELD at R ext 14.4 kG
} at 0.16×10^6 Ampere turns
B max/ <B> 1.3
NUMBER OF SECTORS { compact 3 / separated } Spiral, max deg
SECTOR ANGLE (SSC) deg
TRIMMING COILS 6 coils per plate with summing field on hill sectors
CONDUCTOR, material and type copper
STORED ENERGY (cryogenic) MJ
POWER : main coils 32 max, kW ; current stability 10^{-6}
trimming coils 1 max, kW ; current stability 10^{-4}
WEIGHT : Fe 280 tons ; coils 8.5 tons
COOLING system water
ION ENERGY (bending limit) E/A = 104 q^2/a^2 MeV/amu
(focusing limit) E/A = 104 q /a MeV/amu

ACCELERATION SYSTEM
DEES, number 3 ; angle 60 deg
BEAM APERTURE 3.5 cm ; DC Bias 0 kV
TUNED by, coarse - fine rotating loop
RF 33 to mHz, stable $\pm 5 \times 10^{-6}$
Orb F to 11 mHz
HARMONICS, RF/Orb F, used 3
DEE - Gnd, max 40 kV, min gap 1 cm
STABILITY, (pk-pk noise)/(pk RF volt) 10^{-3}
ENERGY GAIN, max 240 kV/turn
RF PHASE, stable to $\pm$ 1 deg
RF POWER input, max 50 kW
FREQUENCY MODULATION, rate /s
modulator, type
beam pulse, width 0.5 - 3.0 msec

VACUUM SYSTEM
OPERATING PRESSURE 2×10^{-6} Torr or mbar
PUMPS, No, Type, Size 2 diffusion pumps (8000 l/sec + 12 000 l/sec)

ION SOURCES
Internal: Hot cathode Penning; External: Hot cathode Penning, Lambshift, ECR-source

+In house refers to users from KFK

INJECTION SYSTEM
Axial 10 keV, electrostatic with hyperboloid inflector

EXTRACTION SYSTEM
Two electrostatic deflectors + magn. iron channel

FACILITIES FOR RESEARCH
SHIELDED AREA, fixed 350 m² ; movable m²
TARGET STATIONS 8 in 3 rooms
STATIONS served at same time, max 1
MAG SPECTROGRAPH, type
COMPUTER model Two Nova-2; CAMAC
OTHER FACILITIES Large neutron-time-of-flight spectrometer (190 m), resolution 5 psec/m

CHARACTERISTIC BEAMS

PARTICLE	ENERGY (MeV) Goal	Achieved	CURRENT (pμA) Internal	External
$p(H_2^+)$		26 (52)	100	>20
d		52	>1000	≥20
$^6Li^{3+}$		104	50	>10
		156	0.1	0.05
SECONDARY				(part/s)

BEAM PROPERTIES

MEASURED		CONDITIONS
PULSE WIDTH	10 RF deg	1 pμ A of 52 MeV d ions
PHASE EXC, max	20 RF deg	1 pμ A of 52 MeV d ions
EXTRACT eff	>70 %	1 pμ A of 52 MeV d ions
RESOL ΔE/E	0.3 %	1 pμ A of 52 MeV d ions
EMITTANCE		
(π mm. mrad)	{ 9 axial / 6 rad }	5 pμA of 52 MeV d ions

OPERATING PROGRAMS, time distribution
BASIC NUCLEAR PHYSICS 45 % SOLID STATES PHYSICS 30 %
BIOMEDICAL APPLICAT. .... ISOTOPE PRODUCTIONS 10 %
Engineering 15 %

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

PLAN VIEW OF FACILITY, NOTEWORTHY FEATURES, COMMENTS

The Karlsruhe Cyclotron was originally designed for internal isotope production for radiochemistry. After the implementation of the extraction system in 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 production of iodine-123 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 ECR-ion source[3]) 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 1982: ^{12}C, ^{14}N, ^{20}Ne(?) with a fixed energy of 26 MeV/A.

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) 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.
3) HISKA, Status Report and First Injection of ECR-Produced Ions into the Karlsruhe Cyclotron: V. Bechtold, L. Friedrich, H. Schweickert, these Proceedings.