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International Conference on Isochronous Cyclotrons, Gatlinburg, Tennessee,

May 2-5, 1966

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Table I: General DescriptionMagnet

Pole, diameter 224 cm;	Gap, min 19 cm
Sectors, number 3;	Spiral, max 56°
AVF Coils	5 pairs/sector
Circular Trim Coils	17 pairs
Av. Field at r max	17.1 kG
Magnet Power, max, kW	
Main 456, AVF 30, Trim 714	

RF System

Dees 1;	Width 180° ;	Aperture, min 3.8 cm
Frequency range	5.5 to 16.5 MHz	
Dee tuning by	movable panels	
Energy gain, max	140 keV/turn	
PA (or oscillator) output, max	350 kW	

Status

Study _____,	Design _____,	Const. _____
To operate _____, Operating since December 1961		
Now used 24 hr/day,	7 days/week	
Beam on target averages	19 hr/day	

Table I. Continued

<u>Beam</u>	22-130 MeV alphas 10-55 MeV protons
Energy and Particle also d, He ³	
Current, int. $\leq 1000 \mu\text{A}$;	ext. $\leq 100 \mu\text{A}$
Extraction Radius	$\sim 99 \text{ cm}$
External target stations available	9
<u>Shielded areas (concrete)</u>	
Vault 153 m^2 ;	walls 2.3 to 3.0 m thick.
Exp. Rooms 245 m^2 ;	walls 1 to 1.2 m thick.

Cyclotron and Experimental Facilities

A plan view of the 88-inch cyclotron and the associated experimental facilities is shown in Fig. 1. The separately shielded caves make it possible to set up experiments while another experiment is using the cyclotron; thus, the beam time on targets is maximized. The more heavily shielded High-Level Cave (HLC) provides facilities for isotope production and for other experiments which require beams in excess of $10 \mu\text{A}$. With deflection efficiencies near 50%, external beams of about 3 kW beam-power are available. This limit is generally imposed by the heat load on the tungsten septum of the deflector ground electrode. Beams which are energy-analyzed by the switching magnet M_s are available in Caves 1 and 2. An experimental resolution $\Delta E/E$ (FWHM) of 0.09% has been achieved recently with both 90-MeV alpha-particles and 30-MeV protons. This figure includes detector and electronic broadening, and the beam contribution is estimated at 0.07%, which is in good agreement with the value calculated by first order ion optics. Essentially undispersed beams with $\Delta E/E$ between 0.3

and 0.5% are supplied to the HLC, Cave 3, and to the H_2 target inside the cyclotron shielding vault. Recoil protons generated by an alpha-particle beam incident on the H_2 target provide in Cave 5 a variable energy 12 to 63 MeV polarized proton beam.

Methods and results of determinations of the beam characteristics have been reported.¹ These include measurements of current vs radius, internal phase-width vs radius, external beam effective source positions and emittances, and external phase-width and energy correlations.

Recent and Planned Improvements

A regenerative-deflection system has been designed, fabricated, and recently put into operation, and a system to provide axial injection of ions from an external source is being designed. Future plans include a polarized-ion source and an external beam analyzing system capable of a resolution of 0.02% in energy.

Research Program

The Nuclear Chemistry, Physics, and Bio-Physics research programs include the following investigations:

1. Elastic and inelastic alpha-particle scattering from various nuclei.

The recently achieved improved energy resolution has permitted for the first time studies of the excitation of low-lying rotational bands in rare-earth nuclei.

The results yield information on nuclear shapes.

2. The two-nucleon transfer reactions (He^3, p) and (α, d) are studied to provide information both on the reaction mechanism and on the nuclear structure description of the states which are preferentially populated.
3. Proton polarization in $p-d$, $p\text{-He}^4$, and $p\text{-He}^3$ scattering.
4. Study of resonances and threshold effects in $\alpha\text{-}\alpha$ scattering between 23 and 54 MeV. The excitation functions shown in Fig. 2 demonstrate the importance both of small energy spread and of the variable-energy capability of the cyclotron. Some 120 energy changes were made over a 70-hour period of data collection.
5. Final-state interactions in the reactions $\text{He}^3(d, T)2p$ and $T(d, \text{He}^3)2n$ and a determination of the neutron-neutron scattering length.
6. Investigations of isobaric analogue states via (p, He^3) , (p, t) , (α, He^6) , and $(\text{He}^3, \text{He}^6)$ reactions.
7. Determination of the mass of He^8 from the $\text{Mg}^{26}(\text{He}^4, \text{He}^8)\text{Mg}^{22}$ reaction.
8. Studies of $(p, 2p)$, (p, pd) , and (p, pt) reactions with light nuclei yield single particle binding energies and information on cluster structure.
9. Studies of particle-induced fission
10. Bio-physics studies of radiation-induced defects in larvae, biological effects of radiation on tumor cells, and effects of radiation damage on brain tissue.
11. An atomic beam experiment to check the validity of time-reversal invariance of weak interactions.

The distribution of cyclotron time during the period November 1964 through October 1965 was:

	<u>8-hour shifts</u>	<u>%</u>
Nuclear Reactions and scattering research	560	54
Biomedical research	40	4
Isotope production	230	22
Cyclotron research	101	10
Preventive maintenance and scheduled shutdowns	82	8
Repairs (unscheduled shutdown)	<u>18</u>	<u>2</u>
	1031	100

References

1. H. Grunder and F. Selph, Operation of the 88-inch Cyclotron, UCRL-11477, April 1964; H. Grunder, F. Selph, H. Kim, E. Close, and D. J. Clark, Nuclear Chemistry Division Annual Report 1964, UCRL-11828, January 1965.

Figure Captions

Fig. 1. A plan view of the 88-inch cyclotron and the associated experimental facilities.

Fig. 2. Excitation curves for α - α elastic scattering at center-of-mass angles of 55.5 and 90 degrees.

fig. 1

MUB-2569

Fig. 1

MUB-5535

Fig. 2

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