LBNL 88-Inch Cyclotron Improvements*

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The 88-Inch Cyclotron is now operating with beams of higher energy, greater intensity and variety, with more hours of beam on target and supporting a larger number of users than any time since it began operation in 1962. There are two major reasons for this.

First, the development of the ECR ion source by Geller et al[1] and its subsequent development have made it possible to produce a wide range of beams with intensities and energies well matched to the study of nuclear structure, nuclear reaction mechanisms and heavy element research. In addition the 88-Inch Cyclotron which began its operation as a light-ion cyclotron has maintained this capability, which provides research opportunities in new areas such a laser atom trapping for the study of weak interactions and fundamental symmetries.

The second reason is the development of a new generation of high energy resolution detectors such as Gammasphere and Eurogam which has opened up a new area of research in the study of highly deformed nuclei. Much of the research with these new detectors involves the formation of rapidly rotating compound nuclei. Production of the compound nuclei is typically done by using projectiles with $9 \leq A < 80$ with 4 to 6 MeV/nucleon. This research puts strong demands of the ion source capabilities both with respect to making beams from almost every element up to mass 80 and to produce beams economically from separated isotopes. Efficient use of separated isotopic feed material in the ECR sources has been developed. For example in FY94 more than 300 hours of research utilized ^{48}Ca beams with typical usage rate of about 25 µg/hr of 40% enriched ^{48}Ca.

The 88-Inch Cyclotron is nominally a k140 cyclotron with three sectors and three external ion sources. The cyclotron RF frequency can be varied from 5.5 MHz to 16.2 MHz and both first and 3rd harmonic beams are routinely accelerated. Minimum and maximum energies in first harmonic are 6.1 and 55 MeV/nucleon and in third harmonic 0.7 to 6 MeV/nucleon. Currently all beams being used by the research programs are produced by the two high charge state ECR ion sources located on the vault roof of the cyclotron, the LBL ECR ion source and the Advanced ECR

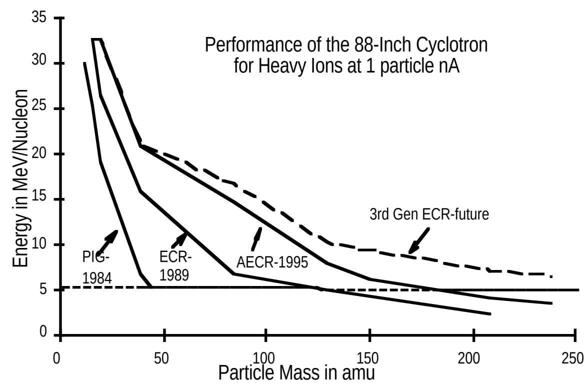

Fig. 1. This shows the energy mass curves for the cyclotron at an intensity of 1 particle nA. The dotted curve shows the projected performance with a new superconducting ECR ion source under development.

The evolution of the heavy-ion performance of the 88-Inch Cyclotron is illustrated in Fig. 1. These curves are drawn for beams of at least 1 particle nA extracted current. Higher intensity beams can be produced at energies less than those indicated by the curves. To date, the 88-Inch Cyclotron has produced beams of 41 elements, from hydrogen through zinc (the first 30 elements) as well as Ge, Kr, Ag, Sn, Xe, La, Sm, Tb, Au, Bi and U.

Footnotes and References

*Condensed from a paper in Proceedings of the 14th International Conference on Cyclotrons and their Applications, Cape Town, S.A, 1995, p173.

1. Geller, R., Appl. Phys. Lett. **16**, No **10**, 401 (1970).