

ANNUAL REPORT  
OF THE  
MICHIGAN STATE UNIVERSITY  
NATIONAL SUPERCONDUCTING CYCLOTRON LABORATORY  
FOR THE PERIOD  
JULY 1, 1983 TO DECEMBER 31, 1984

ACKNOWLEDGEMENTS

COORDINATOR, THEORY GROUP:

SHARI CONROY

COORDINATOR, EXPERIMENTAL GROUP:

CONNIE MERCER DRURY

PRODUCTION COORDINATOR:

CHRIS TOWNSEND

FINAL COMPOSITION, GRAPHICS:

MAMAR BLOSSER

ORILLA MCHARRIS

AUGUST 1985

EAST LANSING, MICHIGAN

## Preface

This Annual Report describes the activities of the National Superconducting Cyclotron Laboratory (NSCL) from July 1, 1983 to December 31, 1984; the eighteen month period of this report effects a transition to a calendar year reporting period, providing a better match to National Science Foundation needs.

During this period the NSCL has come into full, more-or-less routine, operation as a national User's facility. The period began with a shutdown of the K500 cyclotron for a variety of major and minor changes aimed at making its operation more reliable and extending operation to higher energies. When operation resumed in late December, much time was devoted to the development of beam lines and the associated general purpose experimental apparatus; by July, 1984 the S320 spectrograph, the Reaction Product Mass Separator (RPMS), a general purpose gamma-ray chamber, the Enge Spectrograph and an improved chamber for measurements of outgoing neutrons had joined the 60" scattering chamber as developed apparatus ready for general use. At this point the development of apparatus for use in Phase I is essentially complete; because of the priority of the Phase II construction further Phase I improvements will mainly be limited to instrumentation associated with Phase II operation.

Since the shutdown, beam-on time has averaged over eighty hours per week, permitting us to schedule an experimental program of over 4000 hours per year. Meetings of PAC-2 (September 30, 1983) and of PAC-3 (July 2, 1984) were held during the report period. The Committees recommended scheduling of 2104 hours and 1623 hours of beam time, respectively, about half the requested amount. At the time of writing (June, 1984), all experiments approved in PAC-2 have been run, as have most PAC3 experiments and a majority of PAC-4 experiments; PAC-5 will meet on July 28 and 29, 1985 and PAC-6 is tentatively scheduled for January, 1986. Reports on much of the research performed during this period is contained within this report.

At this time Phase II construction is principally directed at finishing the K800 cyclotron, constructing a room temperature ECR source to inject both the K500 and K800 cyclotrons, construction and testing of prototypes of cryogenic beamline elements and construction of initial experimental apparatus for Phase II.

The K800 magnet was operated for the first time on 3 May 1984 and brought to full field shortly thereafter. An extensive program of field measurements demonstrated that the required specifications had been achieved. Work is now centered on installation of trim coils and on computer studies aimed at reducing the electric field in the extraction system, to levels conforming to K500 experience. At the time of the last annual report, difficulties had been encountered with parasitic resonances in the anode tuning circuits of the prototype rf amplifiers; the prototype amplifier was extensively reconfigured, solving the problem; construction of the second and third amplifiers is now underway.

Adding the ECR ion source to the project has had a large qualitative effect on the direction of the laboratory. A room temperature source, about 30% larger than the successful source at LBL is under construction; completion and initial tests are planned for the summer of 1985. Source optimization studies will occupy the remainder of 1985. By early 1986 a system for injecting the ECR beam into the K500 should be ready and will permit operation at substantially higher energies, especially for the heavier ions.

Upon completion of the K800 cyclotron, the laboratory will move into Phase I.5: the ECR + K800 cyclotron will provide beams to a limited set of apparatus, a 4 $\pi$  detector with a broad dynamic range in energy and a large general purpose scattering chamber, 92" in diameter and 119" long, placed in an interim experimental area adjacent to the K800 cyclotron. While this apparatus (and possibly that in

the present S320 spectrometer room) is being used for experiments, the remaining part of the experimental area will be reconfigured with Phase II apparatus and cryogenic beam lines. During Phase I.5, we plan to have available beams of the lighter ions with energies over 150 MeV/nucleon and beams of the heaviest ions with energies above the Coulomb barrier.

Two Conferences were sponsored by the Laboratory during this period. The Tenth International Conference on Cyclotrons and their Applications, organized by an international committee chaired by H. Blosser, was held at MSU 29 April to 3 May 1984. The Proceedings, edited by Felix Marti, have been published as an IEEE Conference Proceedings volume (1984). A Workshop on Interacting Boson-Boson and Bose-Fermion systems, organized by Olaf Scholten, was held at Gull Lake 28-30 May 1984. The Proceedings, edited by Scholten, have been published by World Scientific Publishing Co. (1984).

Two new faculty members joined us in September 1984: Assistant Professor William Lynch who received his Ph.D. from the University of Washington in 1980 and had been at MSU as a Research Associate since that time, and Assistant Professor John Stevenson who received his Ph.D. from the University of California, Berkeley in 1977 and had been an Assistant Research Physicist at Berkeley. After a year at the University of Tennessee and Oak Ridge, George Bertsch will return to MSU in August, 1985.

The first PhD's based on work on the K500 were awarded to Tim Antaya, Haitook Sarafian, Bruce Hasselquist and Barbara Jacak of MSU and Robert Loveman of the University of Washington during 1984; one of these, Barbara Jacak, received a prestigious J. Robert Oppenheimer Fellowship from Los Alamos National Laboratory.

As in the past, we solicit advice and suggestions from you, the reader, not only on the contents of this Annual Report, but also on what we are doing to make the NSCL suitable and convenient for your research.

Sam Austin

Henry Blosser

NSCL Program Advisory Committee

At present the Program Advisory Committee of the NSCL meets about every six months to review proposals for beam time; the possibility of more frequent meetings is under consideration. There are no oral presentations.

Meetings To Date:

PAC-1 February 1982  
 PAC-2 September 30, 1981  
 PAC-3 July 2, 1984  
 PAC-4 January 13-14, 1985  
 PAC-5 July 28-29, 1985  
 PAC-6 January 1986 (tentative)

PAC Members:

Members serve for about five PAC Meetings with one member leaving the PAC after each meeting. The Research Director of the NSCL is Convenor of the Committee. PAC members to date and the meetings at which they have served are:

H.C. Britt (LANL)	1,2
D. Cline (Rochester)	1,2,3,4,5
S.E. Koonin (CalTech)	1,2,3,4,5
P. Paul (Stony Brook)	1,2
D.K. Scott (MSU)	1,2,3
J. Cramer (Washington)	3,4,5
V. Viola (Indiana)	3,4,5
W. Benenson (MSU)	4,5
Non-voting Chair	1,2,3
P. Siemens (Texas A&M)	5

NSCL User's Executive Committee

Members of the User's Executive Committee serve three-year terms, beginning November 1 (formerly two-year terms beginning October 1). Members are elected each year from the general membership of the User's Group, and a non-voting liaison representative from MSU is appointed by the Director of the NSCL. Committees to date are:

October 1, 1982-September 30, 1983

F. Becchetti	University of Michigan, Chair
A. Galonsky	MSU, Liaison
J. Kolata	Notre Dame University
V. Viola	Indiana University
D. Youngblood	Texas A&M University

October 1, 1983-September 30, 1984

A. Galonsky	MSU, Liaison
J. Kolata	Notre Dame University, Chair
F. Prosser	University of Kansas
R. Tickle	University of Michigan
D. Youngblood	Texas A&M University

October 1, 1984-October 31, 1985

A. Galonsky	MSU, Liaison
J. Kolata	Notre Dame University
L. Lee	SUNY, Stony Brook
F. Prosser	University of Kansas
R. Tickle	University of Michigan, Chair

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