

ANNUAL REPORT
OF THE
MICHIGAN STATE UNIVERSITY
NATIONAL SUPERCONDUCTING CYCLOTRON LABORATORY
FOR THE PERIOD
JANUARY 1, 1990 TO DECEMBER 31, 1990

ACKNOWLEDGEMENTS:

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COORDINATOR, THEORY GROUP:

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SEPTEMBER, 1991
EAST LANSING, MICHIGAN

PREFACE

This Annual Report describes the activities of the National Superconducting Cyclotron Laboratory (NSCL) from January 1, 1990 to December 31, 1990. During this period the efforts of the Laboratory were focussed on four principal activities: operating the NSCL as a national user facility; developing the capabilities and reliability of the K1200 Cyclotron; completing the Phase II experimental areas and apparatus; and carrying out a program of research in nuclear science and accelerator/instrumentation science. Considerable resources were also devoted to the development of Electron Cyclotron Resonance Ion Sources, and to the development of accelerators for oncology. Much of this work is described in the technical sections that follow.

Early in February 1990 the experimental program on the K1200 Cyclotron in the interim experimental area located just outside the K1200 vault was completed, and the cyclotrons were shut down for installation of the Phase II experimental areas. That process occurred in stages, with the 4π Array, the 92" Scattering Chamber and the Reaction Products Mass Separator (RPMS) installed in their experimental areas first, concurrent with completion of beamlines in the Transfer Hall. At that point, operation of the K500 Cyclotron could resume while the A1200 Beam Analysis Device was installed in the previous "interim" experimental area. In October the A1200 was completed, and full operation of the facility began. At the end of 1990 only the N4 vault, designed for setups of experiments not involving one of the standard detectors, remained to be completed--N4 will be completed in time for an experiment scheduled in March 1991.

During the shutdown improvements were also made in the K1200 cyclotron and associated equipment. These included changes in the cryogenic system to provide increased flexibility and redundancy; completion and installation of new final rf amplifiers based on the Thomson TH555 tube (these new amplifiers resolved the problems with the earlier rf tubes) and completion of hardware for experiments on the A1200 beam analysis device.

A concerted effort was made to improve the ease and reliability of operation, with encouraging results. Development of new beams remained straightforward, making it possible to perform excitation functions in an efficient fashion. Although the K1200 operated for only about three months, 35 different beams were run during 1990. First measurements with the A1200 operating in its high resolution mode indicate that the energy spread in the raw K1200 beam is less than 0.05%. Experiments on the K500 cyclotron continued, but at a much lower rate than previously, because of the emphasis on K1200 operation and insufficient human and monetary resources to run both machines.

In 1991, development efforts on the K1200 will be aimed primarily at increasing the energy of the beams (of great interest for reaction mechanism studies) and their intensity (of great interest for production of radioactive beams in the A1200 Fragment Separator). Computer calculations have shown that operation at lower rf voltages is possible, permitting higher energy operation for a given rf voltage. This possibility is a consequence of the observed precision and stability of the actual magnetic fields, which exceed that assumed in originally fixing the turn number (and hence the rf voltage) for acceleration. A new central region has been designed for this purpose and is under construction--when installed early in 1991, it will permit operation with significantly lower dee voltages and rf power. This should simplify high energy operation. (Note: at the date of writing ^{20}Ne , ^{36}Ar and ^{84}Kr beams have been obtained at 140, 120 and 75 MeV/nucleon, resp.).

A second improvement will be installation of phase slits near the center of the K1200; these slits will, at some cost in intensity, lead to better time definition in the beam and better extraction efficiency. Finally, the coil structure of the Superconducting ECR source has been upgraded, and the device is scheduled for operation in 1991; this source should improve both the intensity of beams for a given energy and the maximum available energy. Additional shielding of A1200 production targets will be necessary to accommodate the increased energies and intensities that will be available.

A proposal for construction of the S800 Superconducting Spectrograph had been submitted to the NSF in July, 1989. This proposal received excellent reviews, but was not funded because of the tight NSF budget. It is hoped that funding will be available in 1991. Completion of this device is essential to the NSCL program and remains the highest equipment priority of the laboratory.

The NSCL sponsored a number of Conferences and Workshops during 1990. Gary Westfall organized the 6th Winter Workshop in Jackson Hole, Wyoming, January 26 - February 2. A Workshop on A1200 Experiments, organized by Dave Morrissey, was held at MSU, 2-3 February. This workshop was held to familiarize the NSCL user community with the capabilities of the A1200 device and to develop plans for instrumentation necessary to perform the first experiments--38 scientists attended. The 3rd Annual Midwest Nuclear Theory Get-Together was organized by Wolfgang Bauer, and was held at MSU 28-29 September, 1990. A Workshop on High Order Effects in Accelerators and Beam Optics, organized by Martin Berz, was held at MSU, 29-31 October 1990. Fifty participants exchanged information on high order effects, new techniques to treat and analyze them, and their consequences in practical machines.

Dr. Martin Berz, from LBL, joined us as Associate Professor of Physics in July, 1990, and Dr. Michael Thoennessen, from ORNL, joined us as Assistant Professor in November.

In closing, we solicit advice and suggestions from all readers as to any way in which the contents of this Annual Report could be made more useful, and as to things we could do to make the NSCL a more supportive and convenient place to do research.

Sam M. Austin

NSCL Users' 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 |

November 1, 1985 - October 31, 1986

| | |
|-------------|-----------------------------|
| A. Galonsky | MSU, Liaison |
| D. Kovar | Argonne National Lab, Chair |
| L. Lee | SUNY, Stony Brook |
| F. Prosser | Univ. of Kansas |
| R. Tickle | Univ. of Michigan, Chair |

November 1, 1986 - October 31, 1987

| | |
|----------------|--------------------------|
| A. Galonsky | MSU, Liaison |
| D. Kovar | Argonne Natl Lab, Chair |
| K. Kwiatkowski | IUCF, Indiana University |
| L. Lee | SUNY, Stony Brook |
| J. Saladin | University of Pittsburgh |

November 1, 1987 - October 31, 1988

| | |
|----------------|-----------------------------|
| A. Galonsky | MSU, Liaison |
| D. Kovar | Argonne Natl Lab, Chair |
| K. Kwiatkowski | IUCF, Indiana University |
| J. Saladin | University of Pittsburgh |
| L. Sobotka | Washington Univ., St. Louis |

November 1, 1988 - October 31, 1989

| | |
|----------------|------------------------------------|
| T. Awes | ORNL |
| A. Galonsky | MSU, Liaison |
| K. Kwiatkowski | IUCF, Indiana University |
| J. Saladin | University of Pittsburgh |
| L. Sobotka | Washington Univ., St. Louis, Chair |

November 1, 1989 - October 31, 1990

| | |
|-------------|------------------------------------|
| T. Awes | ORNL |
| A. Galonsky | MSU, Liaison |
| A. Nadasen | Univ. of Michigan, Dearborn |
| L. Sobotka | Washington Univ., St. Louis, Chair |
| G. Wozniak | LBL |

November 1, 1990 - October 31, 1991

| | |
|-------------|-----------------------------|
| T. Awes | ORNL |
| A. Galonsky | MSU, Liaison |
| J. Kolata | Notre Dame |
| A. Nadasen | Univ. of Michigan, Dearborn |
| G. Wozniak | LBL, Chair |

NSCL Program Advisory Committee

At present the Program Advisory Committee of the NSCL meets about every six months to review proposals for beam time. There are no oral presentations.

Meetings to date:

| | |
|----|-----------------------|
| 1 | February 1982 |
| 2 | September 30, 1983 |
| 3 | July 2, 1984 |
| 4 | January 13-14, 1985 |
| 5 | July 28-29, 1985 |
| 6 | April 6-7, 1986 |
| 7 | October 26-27, 1986 |
| 8 | May 3-4, 1987 |
| 9 | September 18-20, 1988 |
| 10 | April 29-May 1, 1990 |
| 11 | March 3-5, 1991 |

PAC Members:

| | | |
|------------------|-------------|----------------|
| Britt, H.C. | LANL | 1,2 |
| Cline, D. | Rochester | 1,2,3,4,5 |
| Koonin, S.E. | Caltech | 1,2,3,4,5,6 |
| Paul, P. | Stony Brook | 1,2 |
| Scott, D.K. | MSU | 1,2,3 |
| Cramer, J. | Washington | 3,4,5,6,7 |
| Viola, V. | Indiana | 3,4,5,6,7,8 |
| Benenson, W. | MSU | 4,5,6,7,8,9 |
| Non-voting Chair | 1,2,3 | |
| Siemens, P. | Texas A&M | 5,6,7,8,9 |
| Stephens, F. | LBL | 6,7,8,9 |
| Vary, J. | Iowa State | 7,8,9,10,11,12 |
| Young, G. | ORNL | 8,9,10,11,12 |
| Natowitz, Joseph | Texas A&M | 9,10,11,12 |
| Kashy, E. | MSU | 10,11,12 |
| Hardy, John | Chalk River | 10,11,12 |
| Randrup, Jorgen | LBL | 11,12 |

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