

**ANNUAL REPORT
OF THE
MICHIGAN STATE UNIVERSITY
NATIONAL SUPERCONDUCTING CYCLOTRON LABORATORY
FOR THE PERIOD
JANUARY 1, 1988 TO DECEMBER 31, 1988**

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**December 1989
East Lansing, Michigan**

Preface

This Annual Report describes the activities of the National Superconducting Cyclotron Laboratory (NSCL) from January 1, 1988 to December 31, 1988. During this period the efforts of the laboratory were focused on three principal activities: the operation of the NSCL as a national users' facility, completion of the K1200 cyclotron, and construction of the Phase II experimental areas. Considerable resources were also devoted to the development of Electron Cyclotron Resonance ion sources, whose performance directly affects the performance of the NSCL cyclotrons.

The most important development at the NSCL this year was commissioning of the K1200 cyclotron and the interim experimental area. First K1200 beam was observed on February 18 and the beam was accelerated to full radius on February 22. After a delay to install extraction hardware, extracted beam was achieved on June 6. A period of beam development followed, covering a substantial portion of the operation diagram. Results were very encouraging. Beam was obtained with the calculated operating parameters, and optimized values of these parameters were very close to those calculated. In addition, cyclotron and beam line performance were reproducible from week to week, promising easy operation. Excellent beam emittance of 2π mm-mr was observed. However, K1200 operation revealed a problem with the final amplifier tubes (RCA 4648) of the rf system; a program of modifying the final rf amplifiers to use another tube (Thomson TH555) is now under way. It was also found that at higher values of the magnetic field, fringe fields made injection from the ECR into the K1200 inefficient. A variety of injection line changes will probably be necessary to cure this problem. During the next year we will be involved with the myriad of changes and improvements necessary to improve the reliability of K1200 operation and increase the range of available energies and beams. As of this writing, available beams include several that have the highest energy presently produced by any cyclotron: ^{14}N at 100 MeV/nucleon and ^{20}Ne and ^{40}Ar at 85 MeV/nucleon.

Experiments with the K1200 took place in an interim target area located very near the cyclotron, with the 92" scattering chamber and the 4π detector located behind each other on the same beam line. This arrangement has certain intrinsic limitations in efficiency of setup, but has otherwise worked very well. Radiation and electromagnetic backgrounds from the cyclotron have been unimportant. Good beam quality has made it possible to do clean experiments with the minimal magnetic analysis and focusing possible in this constrained area. The beamline leading to the interim area contains superconducting quadrupoles and dipoles and serves as a test bed for the Phase II superconducting beamlines; operation of this beamline has been smooth and essentially trouble free.

During this year, work was begun (and mostly completed) on an ECR switchyard to make possible switching of the beam from any of the three ECR's to either of the K500 or the K1200 cyclotrons. This arrangement will permit rapid changes of beam, since one source can often be used to develop a new beam while the other is connected to a cyclotron. When the superconducting ECR source is complete, it can be used as the K1200 source when required, but can otherwise be available for the development work necessary to fully develop its capabilities and hence expand the energy range of beams from the K1200.

Work also continued on construction of components of the Phase II beam transport system, including superconducting quadrupoles and dipoles, beam line components and cryogenics. Reorganization and expansion of the experimental areas will take place in 1989, concurrently with operation of the K1200 cyclotron. When this reorganization is complete, around the end of 1989, the K1200 will be shut down for at least three months while the 92" scattering chamber and the 4π array are moved to their new positions. The RPMS and the S320 spectrograph will also be available in the new arrangement. In addition, the A1200 beam preparation device and fragment analyzer will be available. Secondary beams from this device can be transported without loss to all other experimental areas.

PAC-9, the first to consider proposals for the K1200 cyclotron, met September 18-20. It received 38 proposals for a total of 5994 hours (3874 for the K1200 and 2120 for the K500). Allocations of 1877 hours were made for K1200 experiments and 1040 for K500 experiments. PAC-10 will be held at about the time beams are available in the new Phase II experimental areas.

The Fifth Gull Lake Conference, on Phase Transitions in Nuclear Collisions, was held 23-27 May 1988; the conference organizers were Laszlo Csernai and Gary Westfall. Gary Westfall also chaired the Sun Valley Meeting, 23-27 February 1988. An International Symposium on Heavy Ion Research with Magnetic Spectrographs (Chaired by Brad Sherrill and Jerry Nolen) will be held at MSU, January 5-7, 1989. The NSCL will officially dedicate its K1200 cyclotron on 22 May 1989.

Other important developments for 1987 were new additions and changes in laboratory faculty. In September 1988, Associate Professor Pawel Danielewicz, of the Institute of Theoretical Physics, Warsaw University; Assistant Professor Wolfgang Bauer of Cal Tech; and Assistant Professor Aurel Bulgac of the University of Pennsylvania joined the Department of Physics and Astronomy, working in nuclear theory.

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

Sam Austin

NSCL Users' Executive Committee

Members of the Users' 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 Users' Group, and a non-voting liaison representative from MSU is appointed by the Director of the NSCL. Committees to date are:

November 1, 1987 - October 31, 1988

A. Galonsky	MSU, Liaison
D. Kovar	ANL, Chair
K. Kwiatkowski	IUCF
J.X. Saladin	University of Pittsburgh
L.G. Sobotka	Washington University

November 1, 1988 to October 31, 1989

T. Awes	ORNL
A. Galonsky	MSU, Liaison
K. Kwiatkowski	IUCF
J.X. Saladin	University of Pittsburgh
L. Sobotka	Washington University, 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; 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, 1983
PAC-3	July 2, 1984
PAC-4	January 13-14, 1985
PAC-5	July 28-29, 1985
PAC-6	April 6-7, 1986
PAC-7	October 26-27, 1986
PAC-8	May 3-4, 1987
PAC-9	September 18-20, 1988

PAC Members:

H.C. Britt (LANL)	1, 2
D. Cline (Rochester)	1, 2, 3, 4, 5
S.E. Koonin (CalTech)	1, 2, 3, 4, 5, 6
P. Paul (Stony Brook)	1, 2
D.K. Scott (MSU)	1, 2, 3
J. Cramer (Washington)	3, 4, 5, 6, 7
V. Viola (Indiana)	3, 4, 5, 6, 7, 8
W. Benenson (MSU)	4, 5, 6, 7, 8, 9
Non-voting Chair	1, 2, 3
P. Siemens (Oregon State)	5, 6, 7, 8, 9
F. Stephens (LBL)	6, 7, 8, 9
J. Vary (Iowa State)	7, 8, 9
G. Young (ORNL)	8, 9
J. Natowitz (Texas A&M)	9

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