

ANNUAL REPORT
OF THE
MICHIGAN STATE UNIVERSITY
NATIONAL SUPERCONDUCTING CYCLOTRON LABORATORY
FOR THE PERIOD
JANUARY 1, 1991 TO DECEMBER 31, 1991

PREFACE

This Annual Report describes the activities of the National Superconducting Cyclotron Laboratory (NSCL) from January 1, 1991 to December 31, 1991. During this period the efforts of the Laboratory were focussed on four main activities: operating the NSCL as a national user facility; developing the capabilities and reliability of the K1200 Cyclotron; increasing the capability of NSCL detectors; and carrying out a program of research in nuclear science and accelerator/instrumentation science. Considerable resources were also devoted to completing the N4 experimental area and installing there two large pieces of apparatus, to development of Electron Cyclotron Resonance Ion Sources, and to the development of accelerators for oncology. Conceptual planning for a new facility at the NSCL has also begun. Much of this work is described in the technical sections that follow.

At the end of 1990, operation in the Phase II facility had been underway for three months. Since then, the measures that were undertaken to improve the efficiency of operation have had a significant impact. Reliability, defined as (actual hours run)/(scheduled hours) was around 75% a year ago, but has increased steadily to 90%, and the overhead time necessary for tuning beams has been greatly reduced. Running time is now at the rate of about 6000 hours per year, and seventy-two different beams were run in 1991.

During 1991 a low voltage central region was installed in the K1200. This lowered the rf power required for operation and eliminated a voltage holding problem with the rf insulators. Phase slits were installed and initial tests resulted in sub-nanosecond pulse widths. In 1992, 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). At the date of writing ^{12}C , ^{20}Ne , ^{36}Ar , ^{84}Kr , ^{136}Xe and ^{238}U beams have been obtained at 155, 140, 120, 75, 65 and 25 MeV/nucleon, respectively. We anticipate that 200 MeV/nucleon beams of light $N=Z$ nuclei will be available within the next year. The K500 cyclotron has been on "cold" standby for the past year, but may be activated in 1992 for studies related to increasing the intensity of beams in the K1200.

A major development in the experimental program is the growing emphasis on use of the A1200 fragment separator. This device is a source of radioactive beams unique in the U.S. and generally comparable in its capabilities to the separators at GANIL, RIKEN and GSI. Presently about half the approved NSCL experiments are for the A1200, with an emphasis on studies of exotic nuclides. However,

the device is also being used as an energy loss spectrometer of modest resolution and solid angle for studies of single particle and spin strength in nuclei.

During the past year the Reaction Products Mass Separator (RPMS) has been put into use as a post filter for the A1200, to further purify beams produced there, and the 4π Array has been fitted with its Bragg Curve detectors to permit more detailed studies of intermediate mass fragment production. The PPAC detectors which yield low energy thresholds for this detector will be installed in Summer 1992. Significant new apparatus, mainly provided by outside users, will come on line in 1992. BIGSOL, a 7 Tesla solenoid provided by the University of Michigan group has already been installed in the N4 vault and was successfully commissioned in March 1992. A neutron multiplicity filter, SUPERBALL, containing 17,000 liters of Gd loaded scintillator will be constructed by the University of Rochester group and sited in a newly developed S2 vault. The 4π detectors are also being upgraded by outside users. The Washington University group has built a Miniwall to provide greater forward angle granularity for the Miniball and the Indiana University group has provided ion chambers for its detector rings (the Miniball + Miniwall can fit inside the SUPERBALL). Groups from the University of Iowa and the University of Maryland are constructing forward arrays for different angular intervals of the large 4π Array.

A proposal for completion of construction of the S800 Superconducting Spectrograph was submitted to the NSF in July, 1989. This proposal received excellent reviews, but was not funded because of the tight NSF budget. In the interim, some supplementary funds have been obtained to wind the first S800 dipole and to begin construction of the analysis beamline for the spectrograph. We anticipate that major funding will arrive in FY-1993, with S800 completion expected two years later.

The NSCL sponsored a number of Conferences and Workshops during 1991. The 1991 Fall meeting of the Division of Nuclear Physics was held at MSU in October 1991, with Jerry Nolen the Chair of the Local Committee. In conjunction with that meeting there were workshops on: Intensity Interferometry in Nuclear Reactions, organized by George Bertsch and Konrad Gelbke; Physics with Radioactive Ion Beams, organized by David Morrissey and Brad Sherrill; and Nonlinear Dynamics in Nuclear and Accelerator Physics organized by Wolfgang Bauer and Martin Berz.

Other workshops and conferences were: Equilibrium and Non-Equilibrium Phenomena at Finite Temperature, organized by A. Bulgac and D. Kuznezov at Telluride in August and September; Midwest Theory Get-together in East Lansing, organized by W. Bauer; 7th Winter Workshop on Nuclear Dynamics at Key West in January, organized by W. Bauer and J. Kapusta; Workshop on "Excitations in Alkali Clusters", organized by G. Bertsch and D. Tomanek.

Several NSCL researchers have been recognized for their achievements. Henry Blosser of the NSCL and Robert Pollack of IUCF shared this year's Bonner Prize in Nuclear Physics for "their pioneering development of innovative accelerative configurations...". All of us are greatly pleased at this recognition of the founder and first director of the NSCL. Martin Berz was awarded a Sloan Foundation Fellowship and Wolfgang Bauer a Presidential Faculty Fellowship. Brad Sherrill who was previously a member of the NSCL Continuing Appointment System, joined the Department of Physics and Astronomy as Assistant Professor. Jerry Nolen has taken the position of Director of ATLAS at Argonne National Laboratory.

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 improve the capabilities of the NSCL and make it a more supportive and convenient place to do research.

Sam M. 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:

July 1, 1982 - September, 1982

F. Becchetti -- University of Michigan
A. Galonsky -- Michigan State University
J. Huizenga -- University of Rochester
Vic Viola -- Indiana University
G.M. Crawley -- MSU, Liaison

October 1, 1982 - September 30, 1983

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

October 1, 1983 - September 30, 1984

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

October 1, 1984 - October 31, 1985

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

November 1, 1985 - October 31, 1986

D. Kovar -- Argonne National Laboratory
L. Lee -- UNY, Stony Brook
F. Prosser -- University of Kansas, Chair
R. Tickle -- University of Michigan
A. Galonsky -- MSU, Liaison

November 1, 1986 - October 31, 1987

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

November 1, 1987 - October 31, 1988

D. Kovar -- Argonne National Laboratory
K. Kwiatkowski -- Indiana University
J. Saladin -- University of Pittsburgh
L. Sobotka -- Washington Univ. at St. Louis
A. Galonsky -- MSU, Liaison

November 1, 1988 - October 31, 1989

T. Awes -- Oak Ridge National Laboratory
K. Kwiatkowski -- Indiana University
J. Saladin -- University of Pittsburgh
L. Sobotka -- Washington Univ. at St. Louis
A. Galonsky -- MSU, Liaison

November 1, 1989 - October 31, 1990

T. Awes -- Oak Ridge National Laboratory
A. Nadasen -- University of Michigan
L. Sobotka -- Washington Univ. at St. Louis
G. Wozniak -- Lawrence Berkeley Lab
A. Galonsky -- MSU, Liaison

November 1, 1990 - October 31, 1991

T. Awes -- Oak Ridge National Laboratory
J. Kolata -- Notre Dame
A. Nadasen -- University of Michigan
G. Wozniak -- Lawrence Berkeley Lab
A. Galonsky -- MSU, Liaison

November 1, 1991 - October 31, 1992

J. Kolata -- Notre Dame
A. Nadasen -- University of Michigan
U. Schroeder -- Univ. of Rochester
G. Wozniak -- Lawrence Berkeley Lab
A. Galonsky -- MSU, Liaison

Meetings and Members of the NSCL Program Advisory Committee

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-10	April 29-May 1, 1990
PAC-11	March 3-5, 1991
PAC-12	October 27-29, 1991
PAC-13	May 3-5, 1992

PAC Members

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

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/NSCL	1,2,3
Cramer, J.	Washington	3,4,5,6,7
Viola, V.	Indiana	3,4,5,6,7,8
Benenson, W.	MSU/NSCL	4,5,6,7,8,9
	Non-voting Chair	1,2,3
Siemens, P.	Texas A&M	5,6,7,8,9,10,13
Stephens, F.	LB	6,7,8,9,
Vary, J.	Iowa State	7,8,9,10,11,12
Young, G.	ORNL	8,9,10,11,12,13
Natowitz, J.	Texas A&M	9,10,11,12,13
Hardy, J.	Chalk River	10,11,12,13
Kashy, E.	MSU/NSCL	10,11,12,13
Randrup, J.	LBL	11,12
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