ANNUAL REPORT

OF THE

MICHIGAN STATE UNIVERSITY

NATIONAL SUPERCONDUCTING CYCLOTRON LABORATORY

FOR THE PERIOD

JANUARY 1, 1989 TO DECEMBER 31, 1989

ACKNOWLEDGEMENTS:

Coordinator, Experimental Group:
Jackie Bartlett

Coordinator, Theory Group:
Shari Conroy

Coordinator, Accelerator and Operations Group:
Julie Parker

Production Coordinator:
Betty Tsang

Graphics:
Orilla McHarris

AUGUST, 1990
EAST LANSING, MICHIGAN

PREFACE

This Annual Report describes the activities of the National Superconducting Cyclotron Laboratory (NSCL) from January 1, 1989 to December 31, 1989. During this period the efforts of the Laboratory were focussed on four principal activities: operating the NSCL as a national user's facility; developing the capabilities and reliability of the K1200 Cyclotron; constructing the Phase II experimental areas and apparatus; and carrying out a program of research in experimental and theoretical 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 radiation oncology. Much of this work is described in the technical sections that follow.

During 1989 the emphasis of the experimental program was on operating the K1200 Cyclotron in the interim experimental area located just outside the K1200 vault. Only a limited set of experimental apparatus, the 4π Array and the 92" scattering chamber, was available. This program exceeded our expectations in several ways. Interference from rf and radiation proved negligible, and the beams had sufficiently high optical quality and stability that experiments requiring high beam quality were possible even with the minimal magnetic analysis available. Problems with low transmission from the ECR source to the cyclotron were solved and improved ECR performance was achieved by cracking silane onto the ion source walls. These improvements greatly increased the available beam intensity. Coupled with a slow increase in rf performance, this made possible production of beams of ^{14}N, ^{40}Ar, ^{84}Kr and ^{129}Xe at 100, 100, 60, and 50 MeV/nucleon, resp. A concerted effort was made to improve the ease and reliability of operation, with encouraging results: reliability reached over 80% during the last period of operation. Development of new beams remained straightforward, making it possible to perform excitation functions in an efficient fashion; twenty-two different beams were run during 1989. Experiments on the K500 cyclotron continued, but at a much lower rate than previously, because of the emphasis on K1200 operation and conflicts with the construction program.

The cyclotrons will be shut down early in February, 1990 for installation of the Phase II experimental areas and improvements in the Laboratory cryogenics system. During this time improvements will also be made in the K1200 cyclotron and associated equipment. Most important is the modification of the K1200 rf system to use a newer and more reliable final stage tube (Thomson TH455). Because the isochronism and stability of the K1200 magnet exceed original expectations, operation with a larger number of turns (and lower rf voltages) is being considered. Computer studies with the rf voltage lowered by 20% show reasonable operating characteristics and a new central region matched to this voltage has been designed. Implementation of this change will reduce power consumption and should improve stability of operation.

Work has continued on the construction of the experimental vaults and the beam transfer hall, together with all their mechanical and electronic components, in preparation for the February shutdown. During this shutdown the A1200 beam analysis system and fragment analyzer will be installed in the present interim experimental area and the 4π Array (with newly installed Bragg Curve detectors) and the 92" scattering chamber will be moved to their new vaults. Refurbishment of the Reaction Products Mass Separator (RPMS) will be completed: installation of new electrodes in the Wien

filter of the RPMS gave higher operating voltages and improved mass resolution. At the same time the cryogenic system will be upgraded and new data areas will be installed. Slightly later in the fall of 1990, the general purpose vault (N4) will be completed. We anticipate that operation of the K1200 cyclotron in the new experimental areas will begin in September 1990.

Several other important construction projects were completed during this year. The ion source switchyard makes possible switching of beams from any of the three ECR sources to either of the cyclotrons. This arrangement permits rapid beam changes and will facilitate ECR improvements, since a beam can be developed in one source while the other is being used. We intend to use the Room Temperature ECR whenever beam requirements make that possible, so as to free time for study and development of the new superconducting ECR source. The superconducting source is expected to be completed by early summer 1990 and should greatly improve the energy and intensity characteristics of the K1200 cyclotron. For example, it is reasonable to expect that 100 MeV/nucleon Kr beams will be available around the end of 1990. Also during this period the Miniball detector, a portable 4π detector especially suited for studies of multifragmentation, will be ready for testing when beams become available.

During this period the K50 cyclotron was dismantled. This was a memorable moment for many of us, since it was this accelerator that led to founding of the NSCL. Several of the magnet coils from the K50 have been lent to Argonne National Laboratory for incorporation into the APEX experiment--MSU researchers are members of the APEX collaboration.

A proposal for construction of the S800 Superconducting Spectrograph was submitted to the NSF in July, 1989. This proposal received excellent reviews, but unfortunately funds are not available this year. It is hoped that funding will be available in 1991.

The NSCL sponsored a number of Conferences and Workshops during 1989. An International Symposium on Heavy Ion Research with Magnetic Spectrographs, organized by Jerry Nolen, Brad Sherrill and Al Zeller was held at MSU, 5-7 January 1989, and attracted over 100 attendees. A workshop on Medium energy Physics with Heavy and Light Ion Beams was held at MSU, 19-20 June, to discuss the physics that could be performed with intense beams in the 1 GeV/nucleon range--65 scientists attended this meeting. As part of the NSAC long range planning process, a Town Meeting on Nuclear Theory was held at MSU on 25 April. Finally, a SNAP (Small Nuclear Acquisition Projects) Workshop was held at MSU on 9-10 September to permit an interchange of information among those working on data acquisition--there were attendees from ANL, IUCF, Kansas State, LANL, Princeton and Rochester. The 1991 meeting of the Division of Nuclear Physics will be held at MSU.

On May 22, the NSCL officially dedicated the K1200 Cyclotron with a Symposium on Perspectives for Nuclear Science and an Inauguration Ceremony attended by representatives of the University, NSCL alumni, the National Science Foundation and the U.S. Congress.

Other developments for 1989 were a change in the management of the laboratory and a new addition to laboratory faculty. Henry Blosser, founder of the MSU Cyclotron Laboratory and its Director for the past 26 years resigned his position to devote his time and energy to development of new cyclotrons for nuclear physics and for medicine. Sam Austin was named NSCL Director in February 1989. Dr. Martin Berz, presently at LBL, has been appointed as Associate Professor of Physics beginning in summer 1990.

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.

S 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 for this year 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
L. Lee	SUNY, Stony Brook
F. Prosser	University of Kansas, Chair
R. Tickle	University of Michigan

November 1, 1986 - October 31, 1987

A. Galonsky	MSU, Liaison
D. Kovar	Argonne National Laboratory, Chair
K Kwiatkowski	IUCF
L. Lee	SUNY, Stony Brook
J.X. Saladin	University of Pittsburgh

November 1, 1987 - October 31, 1988

A. Galonsky	MSU, Liaison
D. Kovar	Argonne Nat'l Lab, Chair
K. Kwiatkowski	IUCF
J.X. Saladin	University of Pittsburgh
L.G. Sobotka	Washington University, St. Louis

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

November 1, 1989 to October 31, 1990

T. Awes	ORNL
A. Galonsky	MSU, Liaison
A. Nadasen	University of Michigan, Dearborn
L. Sobotka	Washington University, Chair
G. Wozniak	LBL

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 (Texas A&M)	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

TABLE OF CONTENTS

SECTION 1. Page

1. NUCLEAR REACTIONS--EXPERIMENTAL

High Energy Gamma Ray Production from Proton Induced Reactions on C, Zn, Pb at Incident Energies of 104, 145 and 195MeV; J. Clayton, W. Benenson, M. Cronqvist, R. Fox, D. Krofcheck, M.F. Mohar, R. Pfaff, T. Reposeur, J. Stevenson, J.S. Winfield, B. Young, C. Bloch and D.E. Fields 1

Fragment Spectra from $^{36}Ar+^{nat}Ag$ Collisions at 35 MeV/u; H. Hama, I. Anderson, F. Deak, A. Galonsky, C.K. Gelbke, L. Heilbronn, A. Horvath, J. Kasagi, A. Kiss, D. Krofcheck, W. Lynch, T. Murakami, D. Sackett, Z. Seres, H. Schelin, B. Tsang and X. Yang 4

IMF Emission in the ^{14}N + ^{nat}Ag, Au Reaction at $\frac{E}{A}$ = 60-100 MeV per nucleon; J.L. Wile, D.E. Fields, K. Kwiatkowski, K.B. Morley, E. Renshaw, V.E. Viola, S.J. Yennello, R.T. de Souza, C.K. Gelbke, W.G. Lynch, M.B. Tsang, W.G. Gong, H.M. Xu and N. Carlin 8

Projectile Breakup Background in Heavy Ion Transfer Reactions; G. Yoo, G.M. Crawley, J.S. Winfield, S. Gales and S. Fortier 12

^{18}O + ^{58}Ni Reaction at 35 MeV/nucleon; M.C. Etchegoyen, A. Etchegoyen, A.O. Macchiavelli, G.M. Crawley, C. Djalali, M. Renteria, A. Szanto de Toledo and G. Westfall 15

A Technique for Proton-Drip Line Studies Via Fusion-Evaporation Reactions; M.F. Mohar, W. Benenson, D.J. Morrissey, R.M. Ronningen, B. Sherrill, J. Stevenson, J.S. Winfield, J. Yurkon, J. Görres and K. Subotic 19

Spin-Polarized Radioactive Isotope Beams from Intermediate Energy Heavy-Ion Collisions; K. Asahi, M. Ishihara, N. Inabe, T. Ichihara, T. Kubo, M. Adachi, H. Takanashi, M. Kouguchi, M. Fukuda, D. Mikolas, D.J. Morrissey, D. Beaumel, T. Shimoda, H. Miyatake and N. Takahasi . . . 23

Page

Fragment Production Measurements Using Plastic Track Detectors; K. Subotic, D. Novkovic, M. Stojanovic, B. Stepancic, B. Grabez and R.M. Ronningen 26

Production Cross-Sections of P^+, D, T, ^3He, and α for La + La 800 MeV/N Nuclear Collision; J. Bistirlich, H. Bossy, T. Case, A. Chacon, K.M. Crowe, Y. Dardenne, W. McHarris, J.O. Rasmussen and M. Stoyer 27

Azimuthal Distributions of Fission Fragments and α-Particles Emitted in the Reactions ^{36}Ar + ^{238}U at E/A=20 and 35 MeV and ^{14}N + ^{238}U at E/A = 50 MeV; M.B. Tsang, Y.D. Kim, N. Carlin, Z. Chen, C.K. Gelbke, W.G. Gong, W.G. Lynch, T. Murakami, T. Nayak, R.M. Ronningen, H.M. Xu, F. Zhu, L.G. Sobotka, D.W. Stracener, D.G. Sarantites, Z. Majka and V. Abenante 29

Azimuthal Asymmetry in Ar+V Collisions from E/A = 35 to 85 MeV; W.K. Wilson, W. Benenson, D.A. Cebra, J. Clayton, S. Howden, J. Karn, T. Li, A. Nadasen, C.A. Ogilvie, A. Vander Molen, G.D. Westfall, J.S. Winfield and B. Young 33

Reaction Plane Determination; B.M. Young, W.K. Wilson, W. Benenson, C.A. Ogilvie and G. Westfall 37

The Disappearance of Flow and its Relevance to Nuclear Matter Physics; C.A. Ogilvie, W. Bauer, D.A. Cebra, J. Clayton, S. Howden, J. Karn, A. Nadasen, A. Vander Molen, G.D. Westfall, W.K. Wilson and J.S. Winfield 39

Systematic Behavior of the Disappearance of Flow in Heavy-Ion Collisions; D. Krofcheck, G.M. Crawley, C. Djalali S. Howden, C.A. Ogilvie, A. Vander Molen, G.D. Westfall, W.K. Wilson and R.S. Tickle 41

Page

Two-Proton Correlation Functions for Equilibrium and Non-Equilibrium Emission; W.G. Gong, C.K. Gelbke, N. Carlin, R.T. de Souza, Y.D. Kim, W.G. Lynch, T. Murakami, G. Poggi, D. Sanderson, M.B. Tsang, H.M. Xu, D.E. Fields, K. Kwiatkowski, R. Planeta, V.E. Viola, S. Yennello and S. Pratt 43

Proton-Proton Correlation Function in ^{3}He + Ag Reaction at E_{beam} = 200 MeV; F. Zhu, W.G. Lynch, T. Murakami, C.K. Gelbke, Y.D. Kim, T.K. Nayak, R. Pelak, M.B. Tsang, H.M. Xu, D.E. Fields, K. Kwiatkowski, R. Planeta, S. Rose, V.E. Viola, L.W. Woo, S. Yennello and J. Zhang 46

Emission Temperatures from Particle Unstable Complex Nuclei; T.K. Nayak, T. Murakami, W.G. Lynch, K. Swartz, D.J. Fields, C.K. Gelbke, Y.D. Kim, J. Pochodzalla, M.B. Tsang, H.M. Xu, F. Zhu and K. Kwiatkowski 49

The Onset of Simultaneous Multi-Fragmentation; D.A. Cebra, S. Howden, J. Karn, A. Nadasen, E. Norbeck, C.A. Ogilvie, A. Vander Molen, G.D. Westfall, W.K. Wilson and J.S. Winfield 53

2. NUCLEAR REACTIONS--THEORY

The Disappearance of Fusion-like Residues and the Nuclear Equation of State; H.M. Xu, W.G. Lynch, P. Danielewicz and G.F. Bertsch 56

Disappearance of Flow and the In-medium Nucleon-Nucleon Cross Section; W. Bauer, C.A. Ogilvie, D. Krofcheck and G.D. Westfall 60

Single-Photon Decay of Δ-Resonance in Heavy Ion Collisions; W. Bauer, G. Bertsch 62

Critical Pion Opacity; W. Bauer 64

Multiparticle Interactions in High-Energy Collisions with Nuclei; P. Danielewicz and B. Chen 66

Page

Cutting Rules in Many-Body Theory; P. Danielewicz 70

Green Function Approach to Transport Theory of Scalar Fields; St. Mrowczynski and P. Danielewicz 72

Eikonal Models of Fragmentation; G. Bertsch, H. Esbensen and A. Sustich 73

3. NUCLEAR STRUCTURE EXPERIMENTAL

^{12}C Optical Potentials at E/A = 70 MeV; J.S. Winfield, A. Nadasen, N. Anantaraman, S.M. Austin, J.A. Carr, C. Djalali, A. Gillibert, W. Mittig, J.A. Nolen and Z. Wenlong 75

High Lying States Observed in Heavy Ion Transfer Reactions; G.M. Crawley, G. Yoo, S.M. Austin, C. Djalali, W. Benenson, J. Winfield, S. Fortier and S. Gales 79

Gamow-Teller β^{+} Strengths in Fe Nuclei from the (^{12}C,^{12}N) Reaction at E/A = 70 MeV; N. Anantaraman, J.S. Winfield, S.M. Austin, C. Djalali, J.A. Nolen, Jr., A. Gillibert, Zhan Wenlong, W. Mittig and J.A. Carr 82

In-Beam γ-Ray Spectroscopy of Odd-Odd ^{176}Re: Doubly-Decoupled and Compressed Bands; W.-T. Chou, W.A. Olivier, A. Rios-Romero, W.C. McHarris and R. Aryaeinejad 85

Rotational Bands and Possible Superdeformation in ^{132}Pr; C.V. Hampton, A. Rios-Romero, R.M. Ronningen, W.A. Olivier, W.C. McHarris, F. McGowan, J. McNeill, N. Johnson, I. Yang Lee and R. Aryaeinejad 91

4. NUCLEAR STRUCTURE THEORY

Structure of the Collective Lagrangian and Classical Limit of LIE Algebras; A. Bulgac and D. Kusnezov 93

Page

Cross-Shell Excitations Around ^{32}Mg; B. Alex Brown, E.K. Warburton and J.A. Becker 97

Binding Energies for Neutron-Rich Nuclei; B. Alex Brown 100

Adiabatic Time-Dependent Hartree-Fock Theory and Generalized Valley Approximation; A. Bulgac, A. Klein, N. Walet, G. Do Dang 103

Two-Neutrino Double Beta Decay of ^{48}Ca; L. Zhao, B.A. Brown and W. Richter 105

An RPA Program; G.F. Bertsch 111

5. OPERATIONS

Cyclotron Operating Summary; D.R. Poe, H.A. Thulin and P.S. Miller 113

Operation Trouble Report System; P.S. Miller and R. Morin 116

K1200 Magnet Status: Inductance Measurement, Temperature Effects and Modifications; G. Humenik, J. Kuchar, A. McCartney and P. Miller 119

Low Voltage Operation of the K1200 Cyclotron; D.A. Johnson and F. Marti . . . 125

Beam Diagnostics; R.A. Blue, J. Kuchar, F. Marti, J.A. Nolen, B. Sherrill and J. Yurkon 127

Superconducting Beamline Dipoles Progress; J.C. DeKamp, C.T. Magsig, J.A. Nolen and A.F. Zeller 129

Phase II Discrete Control System - User Interface; G. Humenik 131

6. ACCELERATOR R & D

Current Status and Plans for the NSCL Control System Software; L. Foth and J. Priller 133

Page

Current Status of the NSCL Phase II Beamline Electronics Fabrication and Installation; A. McGilvra 134

Current Status of the K1200 RF; J. Vincent, J. Brandon, F. Pigeaud and J. Ottarson 136

Acceleration of Molecular Ions in the K1200 Superconducting Cyclotron; T.A. Antaya, M.L. Mallory, F. Marti, P.S. Miller, J.A. Nolen, D. Poe, B.M. Sherrill and A.F. Zeller 139

Superconducting Beamline Quadrupoles Progress; J.C. DeKamp, C.T. Magsig, J.A. Nolen and A.F. Zeller 142

Superconducting Beamline Quadrupole Harmonic Content; A. Zeller, J. DeKamp, C. Magsig, J. Nolen and D. Tymes 146

K1200 Deflector Development; T. Kuo and J. Nolen 148

High-T_c Superconductors as Thermal Radiation Shields; A.F. Zeller 151

Central Region Calculations for a 250 MeV Superconducting Synchrocyclotron; X.Y. Wu and M.M. Gordon 154

The 250 MeV Superconducting Synchrocyclotron Ion Source Experiment; X.Y. Wu, H. Blosser and T. Kuo 158

Improved Formulas for Calculating Cyclotron Orbit Properties; M.M. Gordon and Dong-O Jeon 162

8-Tesla Magnet for Test Stand; J. Kim, J. Bailey, F. Marti, J. Nolen and H. Blosser 164

Progress on the Medical Cyclotron, H. Blosser, J. Bailey, E. Kashy, F. Marti, R. Morin, R. Ronningen, J. Vincent, J. Wagner, G. Zheng, E. Blosser, G. Blosser, R. Maughan and W. Powers 167

Page

Central Region Studies for the Harper Hospital Cyclotron; J. Bailey, F. Marti and H. Blosser 170

Medical Cyclotron Control System; G. Zheng, R. Morin, J. Vincent, J. Brandon and H. Blosser 175

Preliminary RF System Design for a 220 MeV Proton Therapy Cyclotron; J. Vincent and H. Blosser 189

Differential Algebra Beam Optics for Prediction of S800 Spectrograph Error Terms; A. Zeller, J. Nolen and M. Berz . . 191

Second Order Isochronous Achromat Design with Homogeneous Magnets; D. Ioanoviciu and J.A. Nolen, Jr. 193

Tribology Studies: Implantation of ^{7}Be and ^{22}Na; M.L. Mallory, R.M. Ronningen, Y.X. Dardenne, Wm.C. McHarris and H.J. Schock 196

7. INSTRUMENTATION

The N3 Vault--A General Purpose User Station; D.P. Sanderson 198

The A1200 Beam Analysis Device; B.M. Sherrill, D.J. Morrissey, N.A. Nolen, Jr., C. Snow, G. Stork and J.A. Winger . . 200

The Phase-II Reaction Product Mass Separator; R. Harkewicz, S. Bricker, D.J. Morrissey, J. Nolen, B. Sherrill and D. Swan 204

Operation of the Phase 1.5 Beamline Magnets as a 0-Degree Spectrometer; Measurements of Projectile Fragment Distributions; G.A. Souliotis, D.J. Morrissey, B.M. Sherrill and D. Mikolas . . 205

Page

Status of the MSU 4π Array; G.D. Westfall, S. Bricker, D.A. Cebra, J. Clayton, M. Cronqvist, D. Kataria, D. Krofcheck, R. Lacey, T. Li, M. Maier, L. Morris, T. Reposeur, D. Swan, K. Tyson, A. Vander Molen, W.K. Wilson, J. Winfield and J. Yurkon 208

The MSU Miniball 4π Fragment Detection Array; R.T. de Souza, N. Carlin, Y.D. Kim, J. Ottarson, L. Phair, D.R. Bowman, C.K. Gelbke, W.G. Gong, W.G. Lynch, R.A. Pelak, G. Poggi, M.B. Tsang and H.M. Xu . . 210

Scintillator Foil Fabrication for the MSU Miniball; Y.D. Kim, N. Carlin, R.T. de Souza, R.A. Pelak, C.K. Gelbke, W.G. Lynch and M.B. Tsang 215

Light Pulsing System for the MSU Miniball; L. Phair, T. Peterson, R.T. de Souza, N. Carlin, Y.D. Kim, C.K. Gelbke and W.G. Lynch 218

The S800 Spectrograph; A.F. Zeller, J.A. Nolen and B. Sherrill 220

A Low Cost PIN Photodiode/CsI(Tl) Detector; J. Yurkon, G. Westfall, M. Maier, A. Mueller, B. Sherrill, D. Reinhard and D. Swan 227

Low Energy π^{-}/π^{+} 0° Spectrograph; Y. Chen, E. Kashy, W. Benenson, D. Mikolas and J. Yurkon 229

Nuclear Electronics; M.R. Maier, D.J. Morrissey, K. Niemeyer, M. Robertson and J. Vincent 231

Test of a Separated FET Preamplifier for a Bragg Curve Spectrometer; J. Yurkon, M. Maier, G. Westfall, D. Swan and D. Kataria 232

Experiences with a Mobile Data Acquisition System; R. Fox 233

Status of the 4 Pi Data Acquisition System; A. Vander Molen, R. Au, R. Fox, M. Maier and M. Robertson 235

Page

Status of the APEX Collaboration; E. Kashy, S. Austin, D. Mikolas, J. Winfield, M. Maier and the APEX Collaboration 236

Electronics for the APEX Collaboration; M.R. Maier, E. Kashy, S. Austin, D. Mikolas and J. Winfield 238

Development of a Heavy Ion Detector Array for APEX; D. Mikolas, E. Kashy, D. Kataria, J. Yurkon and the APEX Collaboration 239

APEX Data Acquisition System; J.S. Winfield for the APEX Collaboration 243

A Brazing Furnace Facility at NSCL; D.P. Sanderson, J. Nolen, Jr., S. Hickson and J. Yurkon 245

Heavy Gases, Iso-Octane and C_3F_8, in Charge Particle Detectors; E. Norbeck, J.X. Zhang, R. Dayras, C. Mazur, E.C. Pollacco and D. Swan 246

Page

Energetic (GeV) Light-Ion Production in HI Reactions; F.D. Becchetti, D. Roberts, J. Janecke, J. Brown, K. Ashktorab, W. Liu, A. Nadasen, Z. Yin and D. Shen 248

7 T Superconducting Solenoid Construction; F.D. Becchetti, J. Brown, W.Z. Liu, D.A. Roberts, J. Nolen and A. Zeller 249

SECTION II.

Publications List 250

Conference Proceedings 255

Invited Talks 261

Thesis Titles 264