NSCL

NSCL News Update

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From the Editor

During fiscal year 2006 (the 12-month period ending September 30, 2006), the cyclotrons operated for 5,583 hours with an average availability of 92.2 %. Research beam time was significantly higher than planned and was supported by additional, highly leveraged operating funds from Michigan State University. Twenty-three PAC-approved experiments were performed during this period.

The next meeting of the NSCL Program Advisory Committee (PAC 31) will be held April 24-25, 2007. The call for proposals will be sent to users in mid-January, with proposals due at NSCL on March 16. PAC 31 members are Jim Beene (ORNL), Georg Bollen (NSCL), Morten Hjorth-Jensen (Oslo University), Kirby Kemper (Florida State University), Roy Lacey (Stony Brook University), Robert Tribble (Texas A&M University), Piet Van Duppen (University of Leuven), and Sherry Yennello (Texas A&M University).

A new 5-year cooperative agreement with the National Science Foundation for operation of NSCL as a national user facility and support of its research program during FY2007-2011 began October 1. With the approved funding for FY 2007, we will be able to operate for 3,000-3,500 hours in FY2007 and increase by 500 hours in each of the following two years.

During FY2007 NSCL will operate until May and then have a 4-month shutdown for a major user-endorsed reconfiguration of the experimental vaults. The N2/N3 vaults will be combined to provide space for the sweeper magnet and modular neutron array as well as experiments that do not require a permanent set-up, the S1/S2 vaults will be reconfigured for installing an RF Separator and a neutron time-of-flight reaction setup, and a new A1900 focal plane box will be installed in the Transfer Hall for improved tuning efficiency.

NSCL is developing a reacceleration facility to demonstrate the technical feasibility and performance characteristics for stopping and re-accelerating beams of rare isotopes produced and separated in flight. The concept involves three steps: a) stopping of exotic beams in a novel cyclotron gas stopper, b) breeding the stopped ions to high charges in a state-of-the-art Electron-Beam-Ion-Trap (EBIT) charge breeder, and c) re-accelerating the ions in a modern superconducting linear accelerator, initially up to 3.2 MeV/nucleon.

A detailed white paper (www.nscl.msu.edu/future/isf) on a major NSCL capability upgrade was released in December. The document describes a proposed Isotope Science Facility (ISF), which will provide world-class beams of rare isotopes and take full advantage of short beam development and fast isotope separation times associated with the in-flight production technique. Rare isotopes will be available as stopped beams, as re-accelerated beams from astrophysical energies to 12 MeV/nucleon, and as fast beams.

A new User Executive Committee took office on November 1 for a term of one year. Members are Paul DeYoung (Hope College), Robert Grzywacz (University of Tennessee), I-Yang Lee (LBNL), and Ingo Wiedenhoever (Florida State University, Chair).

Cyclotron Operations

Higher sustained intensity of extracted beam current was achieved for several beams, leading to updates to the published NSCL beam list. For example, the published value of beam current for 140 MeV/nucleon ^{48}Ca, which was raised from 25 pnA to 40 pnA in July 2006, was raised again to 80 pnA in October 2006; and the published value for 160 MeV/nucleon ^{58}Ni was doubled to 10 pnA in December 2006. The enhanced performance is the result of a dedicated development effort that focuses on the beams most in demand by the user program.

A User's Perspective

r-process Experimental Campaign at NSCL

Karl-Ludwig Kratz, Universität Mainz
Jorge Pereira, NSCL

Neutron capture reactions on iron-group nuclei are known to be the most important mechanisms for synthesizing heavy nuclei in the Universe. Two main processes operating on this basis are the slow (s-) and rapid (r-) neutron capture processes. The s-process is reasonably well understood but the r-process remains one of the most challenging open questions in Nuclear Astrophysics. In particular, experiments aimed to study the nuclear structure of neutron-rich nuclei far from stability are crucial for understanding the physics that governs the r-process, as well as the sites where the nucleosynthesis of heavy nuclei occurs.

In this context, a JINA/VISTARS r-process campaign was launched at NSCL in November 2005 by researchers from University of Notre Dame, Universität Mainz, and NSCL. The campaign concentrated on the measurement of unknown β-decay half-lives and β-delayed neutron-emission probabilities (P_n-values) on different neutron-rich nuclei. Experiment 03034 (A. Wöhr, H. Schatz) focused on the region between the N=56 sub-shell closure and the "sudden onset of deformation" at N=60 in the A≅100

region. Experiment 05028 (K.-L. Kratz, J. Pereira) concentrated on the study of "new shell structures" around the possible local, spherical double sub-shell closure at Z=40, N=70, which may help clarify the origin of the calculated r-process abundance deficiencies around A=110. Furthermore, the two regions explored in the studies included some important r-process "waiting-point" nuclei, whose β-decay half-lives and P_n-values are crucial for understanding the r-process abundance pattern.

The experimental setup included the NSCL beta counting system (BCS) and the neutron emission ratio observer (NERO). A double-sided Si detector allowed the position-correlation between implanted nuclei and their subsequent β-decay particles. Half-lives were then extracted by measuring the time differences between implantation and decay events with a 50 MHz clock; additional Si PIN detectors were used for measuring the total kinetic energy of the implanted nuclei and for light-particle veto. After every β-decay, thermalized delayed neutrons could also be measured during a 200μs time interval. Finally, a Ge crystal mounted downstream of the Si stack was tested in order to explore its potential capabilities for gamma spectroscopy and particle identification based on gamma detection from microsecond-isomers.

The experiments successfully identified many nuclei with unknown half-lives and P_n-values, including several interesting waiting-point nuclei. Data analysis is underway at all three of the participating institutions.

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Recent Experiments

May-December 2006

01018— Test of Gamma-Ray Tracking. Experimenters from NSCL and LBNL. Spokesperson: Thomas Glasmacher.
02015—LEBIT - Pilot Mass Measurement Program. Experimenters from NSCL. Spokesperson: Georg Bollen.
03013—Irradiation Studies of DNA (Parts 1 and 2 of 6). Experimenters from Oakland University. Spokesperson: Michael Sevilla.
03026—Two-Proton Knockout in N=40 Nuclei. Experimenters from NSCL. Spokesperson: Przemyslaw Adrich.
03040—Going East in the "Island of Inversion." Experimenters from NSCL, ANL, and Florida State University. Spokesperson: Alexandra Gade.
03045—Two-Particle Correlation Functions. Experimenters from NSCL, ANL, and Florida State University. Spokesperson: William Lynch, INFN Catania (Italy), Indiana University, Washington University, and LANL.
05017—Absolute Spectroscopic Factors in Weakly & Deeply Bound Systems. Experimenters from NSCL and Florida State University. Spokesperson: Alexandra Gade.
05020—Neutron Single Particle States Near ^{78}Ni. Experimenters from University of Tennessee, University of Milan (Italy), University of Warsaw (Poland), Institute of Nuclear Physics (Krakow, Poland), ORNL, Mississippi State University, and NSCL. Spokesperson: Robert Grzywacz.
05043—Measurement of ^{25}Al+p Resonances with p(^{27}Si,^{26}Si*)d. Experimenters from McMaster University and NSCL. Spokesperson: Alan Chen.
05045—Measurement of Excitation Energies in ^{37}Ca. Experimenters from NSCL and University of Notre Dame. Spokesperson: Daniel Galaviz Redondo.
05101—Evidence for Magicity at ^{54}Ca. Experimenters from NSCL, ANL, Florida State University, University of Maryland, and Institute of Nuclear Physics (Krakow, Poland). Spokesperson: Paul Mantica.
05103—Spectroscopy of ^{30}Na Through Beta-Decay of ^{30}Ne. Experimenters from Florida State University and NSCL. Spokesperson: Vandana Tripathi.
05112—Where Adding One Neutron Makes a Difference. Experimenters from University of Maryland, Florida State University, and NSCL. Spokesperson: William Walters.
05122—Deformed and Spherical Excited States ^{30}Na. Experimenters from LBNL and NSCL. Spokesperson: Paul Fallon.
05124—Neutron-Dripline Studies with Direct Fragmentation. Experimenters from Experimenters from Central Michigan University, Concordia College, Florida State University, Hope College, Indiana University–South Bend, Marquette University, NSCL, Wabash College, Western Michigan University, and Westmont College. Spokesperson: William Peters.
05130—Study of Radioactive Molecular Mass Sidebands (Parts 2 and 3 of 3). Experimenters from NSCL. Spokesperson: Georg Bollen.

In Every Issue

Web Update

Information for experimenters can be found at groups.nscl.msu.edu/userinfo/.
The *NSCL News Update* is posted at www.nscl.msu.edu/newsupdate/ with links to previous issues.

Connecting With Us

We welcome your comments on the content and scope of this issue of the *NSCL News Update* and all user-related matters. Please send your comments to Raman Anantaraman at anantaraman@nscl.msu.edu.

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