Nuclear Science Division Newsletter

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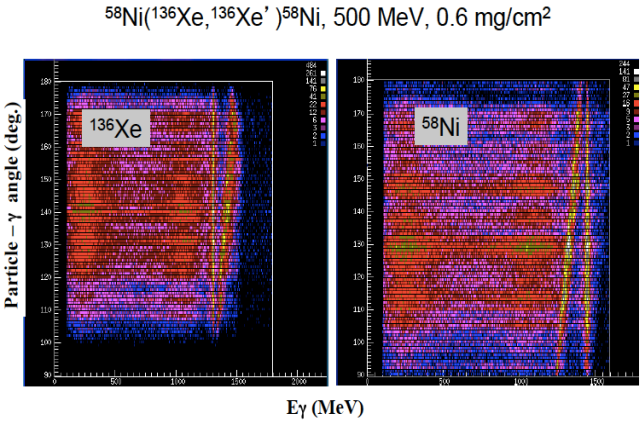
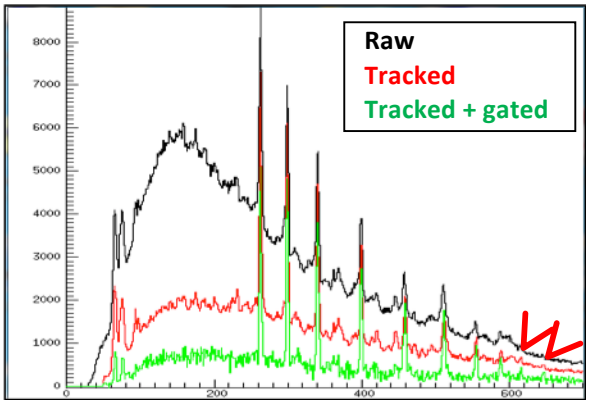
GRETINA is commissioned

Since GRETINA construction was completed in March 2011, a number of engineering runs have been carried out at the LBNL 88-Inch Cyclotron to test the system under typical experimental conditions, to improve its performance, and to further characterize its properties. These conditions included high spin, delayed coincidence, external detectors, high counting rate, high-energy gamma ray, and measurements of linear polarization. For example, the reaction ^{58}Ni(^{136}Xe,^{136}Xe')^{58}Ni, at 500 MeV was used to test coincidence measurements with auxiliary devices, in this case Si-detectors. The upper figure shows the correlation between the angle of the HI and the gammas, as determined by the signal decomposition algorithm, and the silicon detector modules. These data were used to determine an "in-beam" effective position resolution of ~2mm.



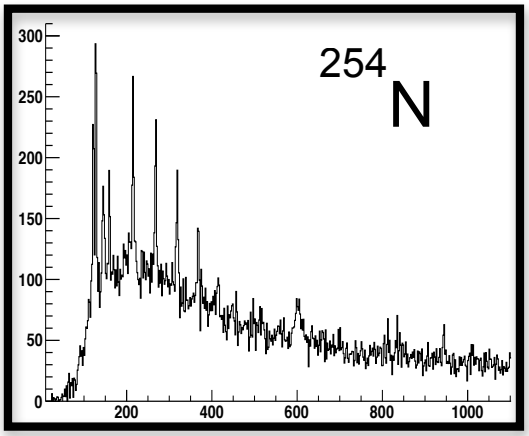
Angle between the photon and outgoing heavy ion in ^{58}Ni(^{136}Xe,^{136}Xe')^{58}Ni reactions seen by GRETINA. From the correlations, a position resolution of 2 mm was inferred.

In September 2011, GRETINA began its commissioning campaign of experiments at the 88-Inch Cyclotron of LBNL. The detector system was installed at the target position of the Berkeley Gas-filled Separator (BGS), as shown in the photo, and coincidence data were taken between the prompt gamma-rays detected in GRETINA and the fusion products detected at the focal plan detectors of BGS. The primary aim of the commissioning campaign was to act as the major debugging phase for GRETINA. The lower figure shows the results from test experiments using the ^{36}Ar+^{144}Sm reaction. ^{176}Pt recoils were separated from the large fission background using the BGS. The effects of tracking and gating on the gamma-rays are illustrated.



The prompt photon spectrum from ^{36}Ar+^{144}Sm reactions, which produce ^{176}Pt. The effects of tracking and time gating on the signal to noise ratio is clearly visible. The x axis is in ADC counts.

A second aim of the commissioning campaign at the BGS was the spectroscopy of transfermium nuclei. This requires the array to run at very high-count rates (>50 kHz per crystal). The figure to the right shows a spectrum for ^{254}No, from the ^{48}Ca+^{208}Pb reaction, before tracking or gating. Several software and hardware improvements have been made to optimize the performance of the array under the extreme conditions required for these types of experiments. In particular, to improve the energy resolution at high rate, additional gain ranges were added to the digitizer and detailed calibration methods for correcting differential non-linearity were developed and implemented. Data analysis is underway.



The photon energy spectrum from ^{254}No, produced from ^{48}Ca+^{208}Pb, taken at count rates above 50 kHz/crystal.

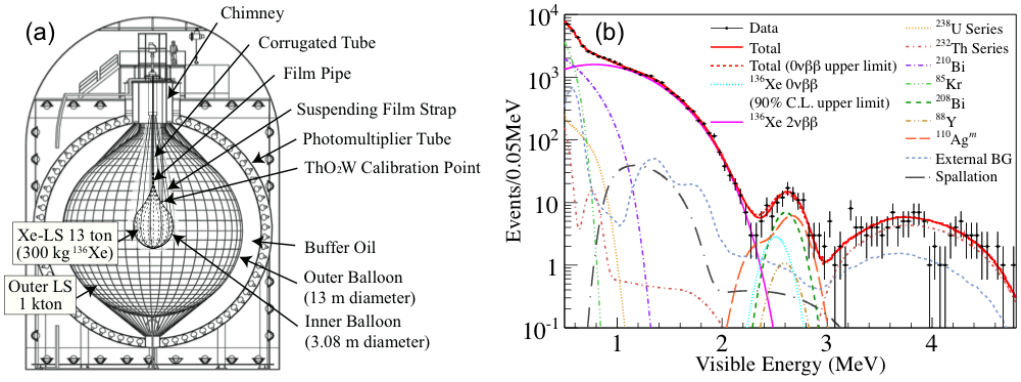
The commissioning runs ended in March, and the move to MSU began immediately. The majority of the hardware arrived on April 23, and by April 27 a ^{60}Co spectrum was successfully taken with one detector module and associated acquisition system installed at the S800 cyclotron. All systems were installed by June 1, as shown in the photo, and the first commissioning run with beam is scheduled for July 9. The MSU PAC approved 24 GRETINA experiment for a total of 3351 hours of beam time, which will run until June 2013.

GRETINA in its new MSU home.

First Results from KamLAND-Zen

KamLAND entered a new phase in the summer of 2011, when a 3-m-diameter balloon containing Xe-infused liquid scintillator was inserted in the detector to enable a search for ^{136}Xe neutrinoless double-beta ($0\nu\beta\beta$) decay. Observation of $0\nu\beta\beta$ would establish the Majorana nature of the neutrino, provide information on the absolute neutrino mass and mass hierarchy, and have a significant impact on high-energy physics and cosmology. However, $0\nu\beta\beta$ decay occurs extremely rarely, if at all, so detecting it requires a huge source and very low background rates. With its large mass and ultrapure environment, the modified KamLAND detector—renamed KamLAND-Zen (KamLAND Zero-Neutrino Double-Beta Decay)—is well suited to search for $0\nu\beta\beta$ decay.

In January 2012, KamLAND-Zen announced its first result [A. Gando et al., Phys. Rev. C **85**, 045504 (2012)], from a 10 ton-day ^{136}Xe exposure. The measured half-life for two-neutrino double-beta decay of ^{136}Xe—a Standard Model process —was $T_{1/2}^{2\nu} = 2.38 \pm 0.02(stat) \pm 0.14(syst) \times 10^{21}\, yr$, in agreement with a recent measurement by EXO-200 but significantly shorter than two previous lower limits. Although a background contamination was observed in the $0\nu\beta\beta$ decay energy window, a lower limit $T_{1/2}^{0\nu} > 5.7 \times 10^{24}\, yr$ (90% C.L.) was obtained for ^{136}Xe $0\nu\beta\beta$ decay. This is a factor of ~5 improvement over the previous limit. The unexpected background— possibly due to radioactive fallout from the March 2011 Fukushima-I reactor accident—is currently being studied and plans for its removal are in development. Removal of this background, in conjunction with radioactive-source calibrations using an LBNL-built deployment device, will significantly enhance the KamLAND-Zen search for $0\nu\beta\beta$ decay. The KamLAND-Zen members from NSD are Tom Banks, Jason Detwiler, Stuart Freedman, Brian Fujikawa, Ke Han, and Tommy O'Donnell.



(Left) Diagram of the KamLAND-Zen detector. The original KamLAND detector surrounds a balloon containing ^{136}Xe-infused liquid scintillator. (Right) Energy spectrum of $\beta\beta$ decay candidates, overlaid with background contributions and best fit (red). The $2\nu\beta\beta$ decay spectrum is clearly visible between 1–2 MeV, while an unanticipated background appears in the $0\nu\beta\beta$ decay peak region between 2.2–2.8 MeV.

SURFs Davis Campus is dedicated

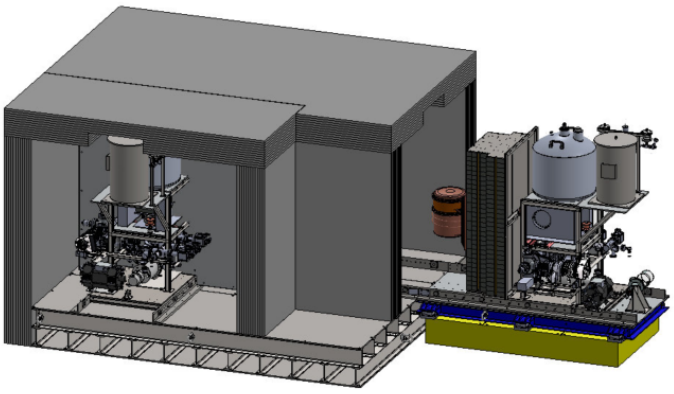
NSF's surprise decision in December 2010, to cease funding the Deep Underground Science and Engineering Laboratory (DUSEL) in South Dakota's former Homestake gold mine required vigorous regrouping by the Department of Energy. Through NSD's Kevin Lesko, Principal Investigator for the project, the Office of Science worked with the state to insure no interruption to science already in the works. On May 30 a crowd of visiting dignitaries and media were introduced to the mint-fresh Davis Campus of the Sanford Underground Research Facility.

Distinguished guests included South Dakota Governor Dennis Daugaard, philanthropist T. Denny Sanford, and Ray Davis's widow, Anna. On the science side, guests included Jim Siegrist, Associate Director for HEP at DOE, and James Symons, NSD director and Berkeley Lab ALD for General Sciences. Fermilab Deputy Director Young-Kee Kim's presence was a reminder that the first stage of Fermilab's proposed Long Baseline Neutrino Experiment is high on the wish list for the next big Homestake experiment.

Media and VIPs hear about the MAJORANA DEMONSTRATOR in the hall that will soon house the experiment.

Almost a mile deep in the mine, the Davis Campus is a gleaming facility that will maintain clean-room conditions to support two experiments that will soon be collecting data, the MAJORANA DEMONSTRATOR, the first step in a search for neutrinoless double-beta decay, and LUX, a dark matter search that stands where Ray Davis mounted his game-changing search for solar neutrinos.

Contributors to MAJORANA include NSD's Yuen-Dat Chan, Jason Detwiler, James Loach, Ryan Martin, Alan Poon, and Kai Vetter, plus Engineering's Mark Amman, Paul Barton, Paul Luke, and Harold Yaver. The proposal to expand LUX to the much larger LUX ZEPLIN detector system is led by Physics's Gil Gilchriese with Bill Edwards and includes Steve Dardin, Vic Gehman, Mia Ihm, and Bob Jacobsen, plus Engineering's Matt Hoff and Joe Saba, and Dianna Jacobs of the Project Management Office.



The MAJORANA DEMONSTRATOR, which will soon fill the hall pictured above.

Two conferences – one week

The week of May 14-18th was a busy one for the Nuclear Science Division, as two different parts of the division were holding two separate conferences in two separate locations. Some 560 registered attendees enjoyed the 2012 IEEE Symposium on Radiation Measurements and Applications (SORMA12) in downtown Oakland, while a group of ~ 25 students and postdocs partook of "The Berkeley School 2012: School of Collective Dynamics in High Energy Collisions" in LBNL's Building 66.

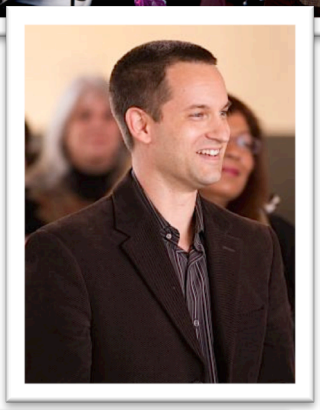
SORMA has grown into one of the major conferences in radiation detection. SORMA12 encompassed 119 oral presentations and 320 posters covering a wide spectrum of radiation detectors, software, and applications. The applications cut a broad swath, from nuclear and particle physics to homeland security and medical applications.

Two plenary talks illustrated the real-world applications, Dr. Steven Aoki (Deputy Under Secretary for Counterterrorism, U.S. Department of Energy) discussed homeland security needs, while Dr. Akira Omoto (Atomic Energy Commission of Japan) gave a sobering talk on the lessons of Fukushima. In between, the sky was the limit; two nuclear physics highlights were I-Yang's presentation of results from the GRETINA commissioning and James Loach discussing recent progress with Majorana. LBNL was well represented in both the organizing committee and the speakers' list. James Symons served as overall co-chair, and most of the program committee were lab scientists and engineers, with Kai Vetter and I-Yang Lee showing the NSD flag. Some 15 speakers had NSD ties (out of a total of 27 from the lab).

Closer to home, the 2012 School of Collective Dynamics continued on the traditions from the 2010 and 2007 schools. This year's school, organized by Nu Xu and Volker Koch, was in honor of Professor Helmut Satz (photo to right, Satz is flanked by Nu Xu and Volker Koch). The 2012 focus, "Lattice Gauge Theory and Charmonium Production," was covered by in 23 lectures, led off by Prof. Satz, on "Quark Matter and Nuclear Collisions: A Tale of Two Topics." The school format, with (usually) four lectures each day, left ample time for discussion. In addition to the pedagogical talks, some of the attendees gave shorter talks about their own work.

NSD Fragments

About 80 Nuclear Science Division members and friends came together on April 12th, to celebrate the impending retirement of longtime NSD budget analyst **Joy Lofdahl** (photo to left, surrounded by husband Eric (left) and NSD Director **James Symons**. Joy spent 34 years with the University of California, 21 of them at Berkeley Lab. At LBNL, she worked in the Relativistic Nuclear Collisions Group for many years, before becoming the Nuclear Science Division Resource Manager.



Although Joy's departure is a big loss for the NSD, we are very fortunate that **Jeremy Coyne** has joined us as a senior budget analyst. Although Jeremy is new to NSD, he has been at the lab for 12 years. He started at the Advanced Light Source before moving to the budget office. More recently, he has worked on project management for ALICE, GRETINA and BELLA within the Engineering Division.

On May 5, NSD joined forces with the Lab's Center for Science and Engineering Education (CSEE) at The Girl Scouts' 100th Anniversary celebration event at the Alameda County Fairgrounds in Pleasanton, CA. Over 10,000 youth and adult participants from Northern California attended the event. NSD and CSEE staff set up display and activity booths in the Girls-Go-Tech pavilion. The NSD team (**Shamsuzzoha Basunia, Sandy Miarecki,** and **Alan Poon**) explained radioactivity in everyday life to the visitors, who also had the opportunity to learn how to use radiation monitors before picking up a befitting souvenir -- a copy of the periodic table signed by former NSD Nobelist Glenn Seaborg.

On April 19, 2012, about 160 colleagues, family and friends gathered on campus at a festive symposium in honor of **Glenn Seaborg**'s 100th birthday, when a series of speakers remembered his career as a nuclear chemist, educator, administrator and diplomat, the latter referring to his work with the nuclear test ban treaty. A special poster session allowed students the opportunity to present their work. The symposium coincided with Cal Day, UC Berkeley's annual open house, and so attracted a number of interested lay people. Glenn's son, David Seaborg (right, with **Darleane Hoffman**) was among the speakers.

A video celebrating Seaborgs legacy is available at: ***http://www.youtube.com/watch?v=4dQg0PAOAwE***

Newsletter Notes

The article on the SURF dedication was courtesy of LBNL science writer Paul Preuss.

Please send any comments, including story suggestions to Spencer Klein at: srklein@lbl.gov.

Previous issues of the newsletter are available at: https://commons.lbl.gov/display/nsd/NSD+Newsletter