**The Efficacy of the National Ignitions Facility's Ergonomic Program.** *NAOMI SHAH (University of California–San Diego, La Jolla, CA 92092) STEVEN MCCONNELL (Lawrence Livermore National Laboratory, Livermore, CA 94550).* Ergonomic injuries have become an increasing concern for office workers and their employers due to the rise in computer-based work. These injuries, as with all chronic injuries, are most prevalent in the older members of the work force due to a longer exposure to chronic insults to their bodies. In 2005, over half of the recorded illness/injury cases at the National Ignitions Facility (NIF) at Lawrence Livermore National Laboratory (LLNL) were ergonomic cases. In order to reduce the number of such cases and their associated costs, NIF has implemented an ergonomic program in which the goal is to evaluate their 1,200 employees. The current process of creating a list of employees who need an evaluation, making an appointment with the employees, performing the evaluation, and following up afterwards proved to have some problems which inhibit efficiency. To enhance the process of forming a list of employees for evaluations, a new database has been developed and is being tested. This allows the evaluator to receive daily updated lists. In order to easily set up appointments and yield a larger response rate, it was found that a Meeting Maker proposal followed by an Email works the best. The evaluator uses the NIF Comfort Survey to help asses the employee's work space; this survey proves to be sufficient in identifying the needs of the employee. Overall, the ergonomic program has made a good start in preventing further ergonomic injuries, and with implementation of the new recommendations, will prove to be an efficacious program.

***Tolerance of Rat's Spinal Cord to Dose-Fractionated Irradiation with Arrays of Parallel X-ray Microbeams.** *SASHEEN FERGUSON (Stony Brook University, Stony Brook, NY 11794) AVRAHAM DILMANIAN (Brookhaven National Laboratory, Upton, NY 11973).* It has been shown that single-exposure to arrays of parallel, synchrotron-generated x-ray microbeams is well tolerated by normal tissues in laboratory animals at doses up to several hundred Gy. The tissues studied include the brain and spinal cord of the rats. We examined such a tolerance to dose-fractionated irradiations with microbeam arrays. Rats were irradiated daily for four days with microbeam arrays made of 27-μm beams spaced 200 μm on-center. The daily in-beam incident dose was 400 Gy. The angles of the irradiations were 45° apart from each other. The animals were monitored by weighing and the behavioral test of "Open Field" to evaluate any potential loss of sensorimotor performance, and the results were compared to those in unirradiated controls. As of 15 days after the last irradiation the rats are gaining weight and performing normally in the Open Field test. They will be kept for one year. Afterwards these animals will be euthanized for histology.

## Nuclear Sciences

**Analysis of the Infrastructure That Will Support a Transition to a Hydrogen.** *TROY MITCHELL (Roane State Community College, Harriaman, TN 37748) JUAN FERRADA (Oak Ridge National Laboratory, Oak Ridge, TN 37831).* The transition to a hydrogen economy is assumed to begin in 2020 with a total of 2.5 million hydrogen cars in seven cities including: Atlanta, Miami, San Francisco, Detroit, Houston, Chicago, and Los Angeles. Factors that affect the transition to a hydrogen economy are production, delivery, storage, and dispensing the hydrogen. Using data from the Department of Energy's Hydrogen Analysis (H2A) models, FLOW©, a simulation program developed at Oak Ridge National Laboratory, can simulate the entire hydrogen economy for each one of the cities used in the analysis. Sensitivity and uncertainty analysis are applied to determine the affects of fluctuating feedstock prices and demand for hydrogen. According to the results of the H2A models, trucking of gaseous hydrogen was not a practical method of delivery. During this research it was found that Python™ is a user friendly object-oriented programming language. In terms of unit cost, natural gas reforming was found to be an effective production method at lower demands for hydrogen, and coal gasification was found to be more effective with higher demands of hydrogen. Steam methane reforming is an effective method of production and distribution, in terms of unit cost. Piping is an effective method to distribute hydrogen at low demands. Trucking is more cost effective when hydrogen demand is higher. Results of the analysis will be used to provide recommendations for the required infrastructure that will provide a better transition to a hydrogen economy from the current fossil fuel economy.

**Candidates for New Transitions in $^{254}$No.** *DAVID GRAYSON (University of Illinois at Urbana Champaign, Urbana, IL 61801) TENG LEK KHOO (Argonne National Laboratory, Argonne, IL 60439).* Several candidates for transitions in $^{254}$No have been observed in an experiment performed at Argonne National Laboratory. The reaction $^{208}$Pb($^{48}$Ca,2n)$^{254}$No was used at beam energies of 219 and 223 MeV. In this report, gamma-gamma matrices were examined to find candidates that were coincident with previously known transitions in the ground state band of $^{254}$No. The candidates found were only evident at 223 MeV, which suggests that they come from parent states with high energies that are not populated at the lower 219 MeV beam energy. The strongest candidate was 469 keV. If this transition feeds in to the top of the previously observed ground state band, then it breaks the pattern of transition energies, which implies a change in structure at that energy. This would have implications for the width of a specific neutron "magic gap", and would help test theories of nuclear structure.

**Development of a Beam Profile Diagnostics Device for the VENUS ECR Ion Source Beam Line.** *CARY PINT (University of Northern Iowa, Cedar Falls, IA 50614) DANIELA LEITNER (Lawrence Berkeley National Laboratory, Berkeley, CA 94720).* This work describes the design and development of the instrumentation for a beam profile diagnostics unit for the low energy beam transport line of the superconducting Electron Cyclotron Resonance (ECR) ion source VENUS (Versatile ECR ion source for Nuclear Science). VENUS is currently being commissioned at LBNL and serves as the prototype ECR injector source for next generation heavy ion accelerators. In order to enhance simulations of beam transport from extraction in VENUS, a measurement device (called a harp) consisting of a grid of thin conducting wires is placed into the beam line, directly downstream from extraction, to measure the beam profile. Utilizing the diagnostics unit developed and described in this work, the first measurements of the beam profile for a simple helium beam are presented. By changing the Glaser current to focus the ion beam onto the harp, the helium beam profiles illustrate that the extracted beam has the same symmetry as the plasma surface from which they are extracted, and not the uniform circular symmetry that is assumed in most simulation models. These results give quantitative insight into the enhancement of initial conditions needed for using simulations to give a physically accurate description of beam transport from extraction of an ECR source.

**Directed Long Range Thermal Neutron Detection System.** *JEFFREY MAGEDANZ (Oregon State University, Corvallis, OR 97333) DR. RAYMOND KLANN (Argonne National Laboratory, Argonne, IL 60439).* A long range thermal neutron detection system could be useful for determining whether a suspected location contains a neutron source. At long ranges, the flux of neutrons from the source becomes small compared to the flux of background neutrons. A bundle of collimator tubes made of a neutron absorbing material could be used to minimize the effect of background neutrons by only allowing neutrons coming from the direction of the source to reach the detector. Monte Carlo N-Particle transport code (MCNP) version 4c was used to simulate a detector with such a collimator bundle in order to study its potential and optimize the design. The simulations determined the response to a moderated californium-252 source at several distances as well as the response to background neutrons. It was determined that cadmium was not an adequate shielding material while materials containing boron, particularly enriched boron, performed well. A 100 cm$^2$ detector with a collimator was found to be reasonably certain to detect a source producing 105 neutrons per second at 30 meters in less than a half hour. However, for greater distances, the time required for detection becomes large. Further research will compare the simulation results to experimental results.

**Gamma-Ray Spectroscopy of Dysprosium-152.** *JASON KOZEMCZAK (Greenville College, Greenville, IL 62246) ROBERT V. F. JANSSENS (Argonne National Laboratory, Argonne, IL 60439).* Nuclei at high excitation energy and spin go through shape deformations, which are a result of interplay between collective and single-particle effects, as they decay to their ground states. Of particular interest are the super-deformed (SD) bands in the A~150 region. In order to assign correct excitation energy, spin, and parity to these SD bands, linking transitions must be observed between the SD bands and the lower-lying normal deformed (ND) bands. $^{152}$Dy is one of only a few nuclei where these linking transitions have been observed. The GAMMASPHERE group at Argonne National Laboratory wishes to map the complete decay process of this isotope so that it can be used to develop a realistic model of this process that will give good predictions of the spins and excitation energies of SD bands where linking transitions have not been observed. To correctly model the decay, the single-particle spectra in $^{152}$Dy have been analyzed to map out the yrast line to the highest angular momentum state possible. The fusion reaction $^{108}$Pd($^{48}$Ca,4n)$^{152}$Dy with a beam energy of 191 MeV was used to populate the ND and SD bands in $^{152}$Dy, and the single-particle level scheme was constructed using triple and quadruple coincidence events.

Angular distribution data have been analyzed to determine the spins of these states. The analysis indicates that the single-particle states stay competitive with the collective states up to very high excitation energy and spin (at least 20 MeV and 48h, respectively). Furthermore, the coincidence analysis has raised questions concerning the placement of a linking transition from a triaxial band to the ND states. Further analysis is needed to place this transition, as such linking transitions allow proper spin and excitation assignment to the triaxial states in question.

**Investigating Applications for the Three-Dimensional Design Information Verification System at Department of Energy Facilities in the United States.** *AARON HANSON (Minnesota State University, Mankato, Mankato, MN 56055) CAMERON COATES (Oak Ridge National Laboratory, Oak Ridge, TN 37831).* The current method used for the annual verification of design information for nuclear facilities under International Atomic Energy Agency Safeguards can be labor intensive since this involves manually verifying that a facility has not been altered over the period of time. This process generally involves comparing new pictures of the facility to previous pictures which can require a great deal of time and effort. A new method was proposed, developed by the European Union's Joint Research Center, which involves using a Three-Dimensional Design Information Verification system. This system uses a laser scanner to take panoramic images of an environment. These two-dimensional images can be made into three-dimensional meshes using accompanying software. The software can automatically compare two three-dimensional images of the same environment and find differences between them. The first of the scans is considered to be a reference scan. The later scan is used for verification, and the verification scan is compared to the reference scan to determine how the environment has changed since the reference scan was taken. In this project, three different environments were set up in order to test the systems capabilities. The first environment was used to determine how well the system could detect large movements (0.5m to 1m) of objects within the environment. The second environment was used to determine how well the system could detect small movements (0.002m to 0.02m) of objects within the environment. The third environment was used to determine if the system can detect the addition of objects to a processing environment. Different conditions were also incorporated into the environments such as making the laser scan through glass and/or water. An analysis of the resulting data showed that the system was able to detect both small and large movements to an accuracy of approximately 4mm, as well as find new objects that were added to the environment. The system is capable of scanning through glass, but not water. The high level of accuracy and the automatic capabilities of the system mean that it will be a significant improvement on the current methods of design information verification for nuclear facilities, although the inability of the system to scan through water might lead to difficulty in some areas that hold large amounts of liquid. Further studies should focus on overcoming this difficulty.

**Optimization of the CLAIRE Ion Beam Extraction and Transport System Using Computer Simulations.** *NAN XU (University of California–Berkeley, Berkeley, CA 94720) DAMON S. TODD (Lawrence Berkeley National Laboratory, Berkeley, CA 94720).* Center for Low Energy Astrophysics and Interdisciplinary Research (CLAIRE) is a proposed nuclear astrophysics facility under design at the Lawrence Berkeley National Laboratory. The facility will measure cross sections relevant to stellar burning, namely ${}_3He({}_4He,\alpha){}_7Be$, a reaction which is one of the leading sources of uncertainty when correlating solar neutrino data with theoretical solar models. A beam line concept has been developed to extract and transport a tightly focused (sub-centermeter), high current (100 mA), low energy (50 keV~300 keV) ${}_3He^+$ ion beam to a high density gas jet target. The beam is first extracted from a plasma ion source, and is then focused by two solenoid lenses. An acceleration column is placed to accelerate the beam to a higher energy. The envelope of the accelerated beam is kept as small as possible by another lens before going through a 60  analyzing magnet for filtering. The last focusing solenoid lens produces the desired beam size on the target. An extensive simulation program was employed to optimize the extraction and the transport of a 100 mA, ${}_3He^+$ beam at 50 keV. The source extraction electrodes will have to undergo further shaping including rounding of corners, but provide the preliminary source configuration that can be used to design the remainder to the beam transport system. Initial work was done on the acceleration column to insure that accelerated beams can arrive at the source with similar qualities, but further modifications of the simulation are needed and further fine tuning must take place for the final design. The detailed analysis of this simulation will be shown and discussed.

**Previous, Current, and Predicted Trends for Applications Using Source Material as Covered by the U.S. Nuclear Regulatory Commission General License.** *CASSANDRA BEATTY (Cornell University, Ithaca, NY 14850) EVA HICKEY (Pacific Northwest National Laboratory, Richland, WA 99352).* With sensitivity to terrorism having heightened since 9/11 and the nuclear energy industry planning to expand in the near future, monitoring the use of fissile and fissionable materials is becoming ever more important. The products and processes that use naturally occurring radioactive materials must be reviewed not only to protect worldwide radioactive resources but the general public as well. The U.S. Nuclear Regulatory Commission (NRC) provides a general license for agencies to use and transfer not more than 15 pounds of materials that contain 0.05% by weight uranium, thorium, or any combination thereof. Regardless, current industrial trends indicate a general decline in the use of thorium and uranium. Thorium was traditionally used in ceramics for refractory purposes but now is primarily used in scientific research and a few electrical applications. Uranium, once popular in pigments and glazes, is now almost entirely limited to military applications that require special licensure and scientific research. Industry substitutes and alternate processes that do not involve uranium and thorium are becoming increasingly popular. If regulatory pressure and public sentiment continue to impede the ease of use of naturally occurring radioactive materials, the NRC general license may become obsolete with respect to uranium and thorium.

**Proton Recoil Detectors and Fission Ionization Chambers for Neutron Dosimetry.** *BRENT WILSON (Merced College, Mered, CA 95340) PEGGY MCMAHAN (Lawrence Berkeley National Laboratory, Berkeley, CA 94720).* Neutrons are ionizing particles, which cause damage to human cells, including astronauts, and electronics. They are difficult to directly detect due to a neutral charge; however, there are several different ways to develop a neutron detector to measure neutron flux indirectly. This research involved the creation and development of two neutron detectors: the prototypes of a proton recoil detector and a fission ionization chamber. The intention was to measure neutrons of 5 to 30 MeV, but since the neutron beam was not available, a proton beam was used instead. A proton recoil detector is composed of a solid-state detector, which electronically counts how many protons are being recoiled out of a plastic medium to determine the incident number of neutrons. In this particular prototype, a 50.0 MeV proton beam was used to show that this prototype worked for the first phase of testing. The next phase of testing will include neutron beams with energies between 5 and 30 MeV for actual proton recoil and a plastic medium containing an ample amount of hydrogen, like polyethylene terephthalate (Mylar). A fission ionization chamber indirectly counts the number of neutrons by means of a gas-filled chamber and fissile foil (e.g., thorium), in which fission fragments produce ion charges, so that measuring the total charge count leads to a calculation of neutron flux. In this particular prototype, an americium-beryllium source was used as a neutron emitter for testing the ion charge collection. The chamber was filled with nitrogen gas at one atmosphere pressure and contained two electrodes, biased to -325 V, and the other used for ion collection to electronics. The prototype fission ionization chamber has just been completed, and tests for functionality are currently being conducted. The next prototype of the fission ionization chamber will include evaporation of the ${}^{232}Th$ onto a window and neutron tests from 5 to 30 MeV in beam.

**Study of Beam Spin Asymmetry in Exclusive $\pi^\circ$ Production.** *IAN HOWLEY (The College of William and Mary, Williamsburg, VA 23186) HARUT AVAKIAN (Thomas Jefferson National Accelerator Facility, Newport News, VA 23606).* Describing and understanding atomic nuclei is a puzzle that has intrigued scientists for decades. Approximately ten years ago, a way to describe nucleon structure, referred to as Generalized Parton Distribution (GPD), was introduced. GPDs are a way of describing scattering and production processes in a single framework. Deeply Virtual Compton Scattering (DVCS) is a process that scatters a photon from a proton and detects a scattered electron, a proton, and one photon in the final state. From DVCS, GPDs can be extracted in order to lead us to a more complete picture of nucleon structure. The focus of this study is to understand the beam spin asymmetry (BSA) of the neutral πo meson, a main source of background during the DVCS process. To calculate the BSA, the number of πo events with positive helicity (spin) and negative helicity were counted by integrating histograms with Gaussians fits. It is shown that there is a significant non-zero BSA in production of exclusive $\pi^\circ$, namely 0.0655 ± 0.0022. In the analysis of previous experiments, the BSA of $\pi^\circ$ was assumed to be zero and therefore ignored. Now, since it is proven to exist, it can be taken into account in future DVCS studies.

A deeper understanding of background processes ($\pi^{\circ}$) in the DVCS will allow precision measurements of GPDs, providing new insight concerning the structure of nucleons.

**System Dynamics.** *JAIMEE WILLIAMS (Brigham Young University, Provo, UT 84602) JACOB JACOBSON (Idaho National Laboratory, Idaho Falls, ID 83415).* VISION (Verifiable Fuel Cycle Simulation Model) is a dynamic model of the nuclear fuel cycle developed at the Idaho National Laboratory (INL). The model tracks the mass of useable fuel, dangerous isotopes, and weapons useable material for adding different types of fuel cycle scenarios to the U.S. reactor fleet. Speed and ease of use differentiate VISION from other more complex models. VISION was developed in a modeling program called POWERSIM, which has uncertainty analysis built in which is necessary to gain a valuable estimation of the cost associated with nuclear fuel cycle. Unfortunately POWERSIM's sampling method fails to distinguish the economic sub-model from the main VISION model. A consequence is that POWERSIM reruns the entire model each time the economic sub-model is run; although no new information is gained. A good sampling size of 10,000 runs at thirty seconds per run would take three and a half days. The objective of this project was to develop a simple sampling method implementing a Latin hypercube algorithm. Latin Hypercube Sampling (LHS) is a stratified sampling technique where the random variable distributions are divided into equal probability intervals. A probability is randomly selected from within each interval for each basic event. Generally, LHS will require fewer samples than simple Monte Carlo Sampling. However, due to the stratification method used, it may take longer to generate a value than for a Monte Carlo Sampling however, the LHS technique will give us a more accurate cost analysis. The Latin hypercube algorithm we implemented works by dividing up the cost distributions into two hundred equally probable events and randomly sampling from them. The key to our approach was decoupling the economic sub-model from the main model, meaning we only ran the VISION model once for numerous iterations on the economics sub-model. Our new approach allowed us to sample 10,000 runs in two minutes, which is a vast improvement over the old sampling methods. The approach implemented allows VISION users to easily access cost analysis data without waiting for extended periods of time. This is in keeping with the objectives sought by VISION; speed and ease of use.

**The Optimization of Environmental Sample Data Analysis and Visualization.** *MATTHEW ANDERSEN (Southern Adventist University, Collegedale, TN 37315) DIANE FISCHER (Oak Ridge National Laboratory, Oak Ridge, TN 37831).* For the last 10 years, the International Atomic Energy Agency (IAEA) has been collecting, organizing, and storing vast amounts of environmental sampling (ES) data. ES data are used by the IAEA to detect undeclared nuclear activities all across the world. Currently, the analysis of this data is time-consuming and inefficient due to a lack of integrated data evaluation tools. The first objective in providing a solution to this problem was to evaluate multiple software suites used in data modeling. The second objective was to develop an easy-to-use, multifunctional graphical user interface (GUI) that allows quick customization and visualization of ES data analysis information using one, or a combination of several, of the options explored in the first objective. The evaluation process included examining the software's documentation; downloading and testing freeware, trialware, or full versions of the software; and attending software tutorials. Initial models for the interface were based upon current IAEA methodologies and inquiries concerning desired features for the data analysis and visualization output. Several books on nuclear forensics and programming were used in the maturing of the GUI's design and functionality. The finalized GUI was developed for the Microsoft Excel 2003 software package using Excel's integrated Visual Basic for Applications programming language. This new interface allows users to more efficiently add to or modify the visualization of the data. Fast access to functionality not previously available was also incorporated. New features include the ability to plot multiple data sets on the same graph, based on country, facility name, facility code, material balance area, location, or any combination of these, as well as the ability to remove specific data sets from a given graph. This new GUI gives the IAEA a graphical tool that will aid in understanding and analyzing ES data. The improvements offered by the software will allow personnel to make more efficient use of their time while having the tools needed to help them make more-informed decisions. The customization and functionality of this new model permits adaptation to many other data analysis and visualization scenarios, not just those involved with nuclear safeguards data. As with any software, future work will include adjustment to new technology and the implementation of additional features as output requirements change.

**The Standardization and Upgrade of Isotopic Enrichment Measurement Software through the Analysis of Enriched Uranium Standards.** *LINDSAY OWENS (Brigham Young University–Idaho, Rexburg, ID 83460) MARY D. EIPELDAUER (Oak Ridge National Laboratory, Oak Ridge, TN 37831).* There are many accepted isotopic enrichment measurement software packages used to identify and measure levels of enriched uranium and plutonium. The basis for the following project has come about in response to inconsistencies in the types and versions of software being used. In addition to comparing the accepted software, the goal is to decide on a single international standard. The United States Department of Energy/National Nuclear Security Administration through Oak Ridge National Laboratory (ORNL), Lawrence Livermore National Laboratory, Los Alamos National Laboratory, in conjunction with the Brazilian-Argentine Agency for Accounting and Control of Nuclear Materials, are testing and evaluating isotopic enrichment measurement software packages to identify the most effective software. The software packages undergoing testing at ORNL are: WinU235, NaIGEM, MGAU (v3.21 and v4.0), and ISOTOPIC. In order to test these software programs, the Safeguards Laboratory at ORNL is conducting eight experiments. The setups for the experiments consist of germanium and sodium iodide detectors in combination with a variety of multi-channel analyzers. The experiments have been prearranged to include a variety of different measurement distances, attenuator materials, and thicknesses of attenuators. The eight uranium standards used range from depleted uranium (0.31% enriched) up to highly enriched uranium (93.17% enriched). For each standard, spectra are collected for 1000 seconds and repeated for six trials. In Experiment 1, which used a Canberra Planar germanium detector with a MCA-166 multi-channel analyzer, the spectra were analyzed using MGAU v3.21, and the six trials for each spectrum were condensed by calculating the averages for the following categories: Measured Percentage of U-235 - Declared Percentage of U-235, Standard Deviation [Measured - Declared/Declared Weight Percentage], Measured Percentage of U-235, Absolute Error, and Percent Error. The work completed thus far is a small part of a much larger project, and thousands of spectra remain to be analyzed. In order to better understand how the software programs compare to each other and eventually decide upon a single international standard, the data gleaned from analyzing the spectra must be compressed and organized in such a way that a comparison can be made. A significant amount of work remains in the present efforts to standardize and upgrade existing isotopic enrichment measurement software.

**Thermo-hydraulic Design and Analysis of Lead Coolant Test Facility (LCTF).** *RYAN DALLING (Brigham Young University–Idaho, Rexburg, ID 83440) SOLI KHERICHA (Idaho National Laboratory, Idaho Falls, ID 83415).* The Lead Fast Reactor (LFR) is one of the six concepts selected on the Generation IV Road Map by the Generation IV International Forum. If certain technical innovations can be proven in the LFR reactor concept, it will provide a unique and attractive nuclear energy system. Thus, advancement of the LRF beyond the conceptual phase will require lab demonstrations and tests involving many research and development issues. The Idaho National Laboratory (INL) is working on such test loops by further developing the LCTF. The laboratory demonstration of key attributes of the LFR design can be provided by the LCTF which would conduct such tests on certain issues. The thermo-hydraulic tests will allow the LCTF to prove the functionality of the many attractive attributes provided by the LFR. In order to build the LCTF, a thermo-hydraulic analysis of the LCTF was conducted to produce a proposed preliminary design and concept. This analysis was first conducted using a Microsoft Excel spreadsheet with lead as the primary coolant, and then conducted in RELAP5-3d with lead-bismuth as the primary coolant. An envelope of variation of various LCTF parameters providing different design options was created using the results of these analyses, which will facilitate any further R&D needs in the future when the LCTF is to be further developed. The two models (Excel, RELAP5-3d) provide sufficient, valuable information to make preliminary design decisions of the LCTF.

**Tritium Diffusivity in Metals; Response of a Tritium Monitor To Cs-137 Gammas; Dose-Response Relationship Function of Species Mass, DNA Content and Chromosomes.** *CHRISTOPHER COPELAND (Morehouse College, Atlanta, GA 30314) MICHAEL SINGH (Lawrence Livermore National Laboratory, Livermore, CA 94550).* Tritium will be used as a fuel for the NIF ignition experiments. Understanding its behavior in various materials is important to evaluate inventory and to develop safety plans for handling tritiated hardware. Since tritium monitors will be used for evaluating airborne tritium concentration, the response of tritium monitor, an ion chamber, was calculated as a function of distance from the center of the chamber to the source location. A Cs-137 gamma check source was used to determine the experimental response of the meter as a function of distance from the center of the chamber. Cs-137 emits beta radiation (95% – 0.514 MeV, and 5% – 1.18 MeV; with 0.661 MeV gammas). Its half-life is about 30.07 years. By correlating a simple relationship between the tritium energy deposition and gamma energy deposit in the chamber volume, an external gamma source can be used to both check the response and calibrate the meter precisely. Also had a brief opportunity to study the radiation dose-response relationship, primarily for acute doses, for various species as function of DNA content, number of chromosomes, body mass, etc. Some discussions were held in the areas of radiobiology and nuclear medicine.

## Physics

**$^{24}$Al Level Structure and the Corresponding $^{23}$Mg(p,α) $^{24}$Al Astrophysical Reaction Rate.** *CHRISTOPHER DEATRICK (Western Michigan University, Kalamazoo, MI 49008) DARIUSZ SEWERYNIAK (Argonne National Laboratory, Argonne, IL 60439).* In order to better understand the processes involved in heavy nuclide production in explosive stellar environments, the breakout process from the CNO cycles to the NeNa cycle and to the MgAl cycle must be quantified. Better numerical values of proton capture rates are deduced for the $^{23}$Mg(p,α) $^{24}$Al reaction by studying nuclear energy levels in $^{24}$Al above the proton capture threshold using high-resolution α-ray spectroscopy and α-ray angular distribution analysis. $^{24}$Al nuclei were produced by colliding an $^{16}$O beam delivered by the Argonne Tandem-Linac Accelerator System with a $^{10}$B target. Excited states in $^{24}$Al were populated after evaporating two neutrons from the compound system. Gamma rays emitted from these states were detected with the GAMASPHERE array of Compton-suppressed Ge detectors. The Argonne Fragment Mass Analyzer was used to separate reaction products from the beam and assign mass and atomic numbers. As a result, states above and below the proton threshold were studied in detail resulting in an improved $^{24}$Al level scheme. The analysis of the first state above the proton threshold indicates that the reaction rate contribution of this state could differ by a factor of up to 9 from that of previous calculations in the 0.1–0.5 GK temperature range.

**3D Simulation for the ATLAS Education and Outreach Group.** *BRIAN AMADIO (Rensselaer Polytechnic Institute, Troy, NY 12180) MICHAEL BARNETT (Lawrence Berkeley National Laboratory, Berkeley, CA 94720).* ATLAS is a particle detector under construction at the Large Hadron Collider facility at the CERN Laboratory in Geneva, Switzerland. The project will be the most expansive physics experiment ever attempted. The ATLAS Education and Outreach Group was started to provide information to students and the general public about the importance of this project. A three-dimensional interactive simulation of ATLAS was created, which allows users to explore the detector. This simulation, named the ATLAS Multimedia Educational Laboratory for Interactive Analysis (AMELIA), allows users to view detailed models of each part of the detector, as well as view event data in 3D. A similar project is called ATLANTIS, which allows users to examine events in only two dimensions. Currently ATLANTIS allows more sophisticated analysis of events. AMELIA will provide similar functionality, but in a more intuitive way, which will be much friendlier to the public.

**A Catalog of Candidate High-Redshift Blazars for GLAST.** *TERSI ARIAS (San Francisco State University, San Francisco, CA 94132) JENNIFER CARSON (Stanford Linear Accelerator Center, Stanford, CA 94025).* High-redshift blazars are promising candidates for detection by the Gamma-ray Large Area Space Telescope (GLAST). GLAST, expected to be launched in the Fall of 2007, is a high-energy gamma-ray observatory designed for making observations of celestial gamma-ray sources in the energy band extending from 10 MeV to more than 200 GeV. It is estimated that GLAST will find several thousand blazars. The motivations for measuring the gamma-ray emission from distant blazars include the study of the high-energy emission processes occurring in these sources and an indirect measurement of the extragalactic background light. In anticipation of the launch of GLAST we have compiled a catalog of candidate high-redshift blazars. The criteria for sources chosen for the catalog were: high radio emission, high redshift, and a flat radio spectrum. A preliminary list of 307 radio sources brighter than 70mJy with a redshift z = 2.5 was acquired using data from the NASA Extragalactic Database. Flux measurements of each source were obtained at two or more radio frequencies from surveys and catalogs to calculate their radio spectral indices α. The sources with a flat-radio spectrum (α = 0.5) were selected for the catalog, and the final catalog includes about 200 sources.

**A Geant4 Simulation of the COUPP Bubble Chamber.** *CHARLES CAPPS (Carnegie Mellon University, Pittsburgh, PA 15289) ANDREW SONNENSCHEIN (Fermi National Accelerator Laboratory, Batavia, IL 60510).* It is known that a sensitivity on the order of 1 event per year per ton of detector material is necessary to detect a WIMP (Weakly Interacting Massive Particle) dark matter candidate. After successful veto of cosmic radiation, the neutron background will become the greatest obstacle for COUPP (Chicagoland Observatory for Underground Particle Physics) to achieve this level of sensitivity. Thus, understanding the COUPP bubble chamber's response to low-energy neutrons (< 50 MeV) is crucial. A Geant4 simulation of the COUPP bubble chamber response to an Am/Be neutron source is described. The recoil energy spectra given by the simulation are presented. Simulation results of event rate as a function of chamber pressure are compared to experimental data. Moreover, multiple bubble events—indicative of neutrons—are examined. The ratio of single to multiple bubble events is determined for different energy thresholds. To verify Geant4 for neutrons in this energy regime, cross-sections and differential cross-sections are computed from the simulation and compared to the JENDL, JEFF, and ENDF nuclear databases. Elements present in the COUPP experiment are considered. Good agreement is found between simulation cross-sections and the above nuclear databases.

**A Numerical Model of the Critical Charge Density Surface of Ultra High Energy Cosmic Ray Induced Extensive Air Showers Using the SCILAB Programming Language.** *ALLEN SHARPER (Florida A&M University, Tallahassee, FL 32301) HELIO TAKAI (Brookhaven National Laboratory, Upton, NY 11973).* A numerical model of the critical charge density surface of ultra high-energy cosmic ray (UHECR) induced extensive air showers (EAS) has been computed. The critical charge density surface defines the surface for specula reflection of radio waves with frequency less than the natural oscillation frequency (plasma frequency) of the EAS charges. Using a numerical model to understand how radio waves reflect from the air shower will help improve the design of devices (antennas, arrays) used to detect the reflected waves. The numerical model will allow the power and direction of the reflected waves to be calculated which will provide a map of the spatial distribution of reflected wave power and polarization incident to the surface of the earth. The program of the numerical model, written in the SCILAB language, calculates the density of ionization electrons as a function of radial distance from the shower axis and location along the axis. The cosmic ray tracing model is part of the Mixed Apparatus for Radar investigation of Cosmic-rays of High Ionization (MARIACHI) project. The MARIACHI project, consist of research that investigates an unconventional way of detecting UHECR. Based upon a method successfully used to detect meteors entering the upper atmosphere. Mariachi seeks to listen to television signals reflected off the ionization trail of an UHECR.

**A Plasma Gun for the Next Generation of Spallation Neutron Source $H^-$ Ion Sources.** *JUSTIN CARMICHAEL (Worcester Polytechnic Institute, Worcester, MA 01609) ROBERT F. WELTON (Oak Ridge National Laboratory, Oak Ridge, TN 37831).* The ion source for the Spallation Neutron Source (SNS) is required produce 40-50 mA of $H^-$ current depending on emittance with a duty factor of ~7% for baseline facility operation. The SNS Power Upgrade Project requires this current to be increased to 75–100 mA at the same duty factor. In its present form, the baseline SNS ion source is unable to deliver this performance over sustained periods of time. A new generation of RF-driven, multicusp, ion sources based on external antennas are therefore being designed to meet these requirements. It was found that by injecting a stream of plasma particles from a simple, steady-state, DC glow-discharge into the RF-plasma (i) $H^-$ production can be dramatically increased and (ii) $H^-$ pulse rise time can be significantly reduced. The design of a suitable plasma gun is presented which features a hollow anode and mechanical compatibility with the new ion sources. The Finite Element Method (FEM) has been employed to optimize the design: coupled fluid dynamic, heat transfer, mechanical stress and deformation, and ion/electron trajectory simulations were performed. Several design improvements over earlier versions were implemented such as the addition of an extraction system. The FEM simulations showed that the design of the new plasma gun is sufficient to handle the thermal stresses resulting from a 1 kW load on the cathode face. The ion/electron simulations demonstrated a high degree of control over the plasma beam, allowing for manipulation of the intensity, mean energy, and divergence of the streaming plasma. The extraction system also allows for selective emission of electrons or ions. It is anticipated that the plasma beam can be optimized with the extraction system to significantly increase the $H^-$ current in the new ion sources.