Exotic Beams Summer School 2014,
ORNL, 28th July-1st August 2014
Hands–on activities

1. Neutron detection techniques with digital systems

Robert Grzywacz, Kay Kolos, Nathan Brewer

We propose to showcase different neutron detection techniques using scintillator detectors and 3He counters. We will use the digital data acquisition systems to demonstrate its advantages in experiment. For the neutron time of flight measurements, students will implement a simple digital timing and neutron gamma discrimination. Using 3He neutron counter array and gamma ray detector, they will measure the neutron thermalization time. In order to perform these measurements 252Cf source and standard gamma ray sources like 60Co will be used.

2. An introduction to total absorption spectroscopy

Marek Karny, Marzena Wolinska, Ola Fijalkowska

The total absorption spectrometry technique will be introduced to the EBSS participants.
The world largest total absorption array of Modular Total Absorption Spectrometer (MTAS) will be used to measure 60Co activity and a complex decay of 110mAg. Single Ge detector will be used to measure 60Co gamma radiation. Students will match and calibrate the energy spectra of 19 MTAS modules using 60Co source. The difference between gamma spectra measured with a single Ge detector and MTAS will be demonstrated and explained. The response of different MTAS rings to the emitted radiation will be measured and analyzed. The role of beta coincidences and beta trigger will be demonstrated and explained using measured 60Co and 110mAg spectra.
The advantages of very high MTAS full energy and total efficiency as well as a need for heavy shielding will be discussed.

Reference: A. Fijalkowska et al, APPB 45, 545, 2014,
http://www.actaphys.uj.edu.pl/_cur/store/vol45/pdf/v45p0545.pdf

3 . Digital Gamma-Ray Spectroscopy

Mitch Allmond and David Radford

Students will be given the opportunity to learn about conventional and new point-contact HPGe detectors. Signals from both detector types will be explored in real time using sealed gamma-ray sources and an oscilloscope. Afterwards, an introduction to pulse-shape analysis (PSA) will be covered. Digitized pulses (traces) from an HPGe preamplifier will be analyzed. Techniques for determining the energy and time of each pulse will be demonstrated initially with simple arithmetic using a spreadsheet. Participants will implement their own PSA algorithm (C template code provided), which will be applied to real gamma-ray data. These sessions will explore concepts fundamental to the operation of next generation gamma-ray spectrometers such as GRETINA/GRETA.

4. Detectors for Nuclear Astrophysics

Steve Pain, Kelly Chipps

Direct measurements of capture reactions involving unstable nuclei for nuclear astrophysics require gas targets and large recoil separators (such as the SECAR device planned for the ReA3 facility) to filter the capture products from the highly intense flux of unreacted beam particles. Students will use the Daresbury Recoil Separator to learn about the operation of the elements which comprise a state-of-the-art recoil separator, along with the operation of a windowless gas target.
Students will, by accounting for relevant effects, tune alpha particles through magnetic and electrostatic elements to detectors at the DRS focal plane, including a fast ionization chamber and position-sensitive detectors.

5. Simulations of Explosive Nucleosynthesis

Michael Smith

This activity will train participants to use the Computational Infrastructure for Nuclear Astrophysics [CINA] to determine the astrophysical impact of their laboratory or theoretical results, as well as to plan future measurements and studies with the largest astrophysical implications. The fundamentals of simulations of nucleosynthesis in stellar explosions will be described, along with the specific implementation in CINA. Participants will learn to convert cross sections into reaction rates, use these rates in simulations, and compare simulation results using different nuclear input. They will also learn how to perform studies to determine the sensitivity of simulation results on nuclear input, as well as perform exploratory simulations that can guide their future research and provide information for proposals for beam time and for project funding.

6. Hands on Nuclear Shell Model

Thomas Papenbrock and Gaute Hagen

(with Kyle Wendt, Angelo Signoracci and Gustav Jansen assisting)

The theory activity consists of running shell-model codes (e.g. Morten Hjorth-Jensen's code or Alex Brown's code) on personal laptops. The participants will become familiar with these programs and will be asked to perform simple calculations (e.g. spectra, wave-function structure, transitions) themselves. We will consider various interactions and model spaces. The activity will be performed in the large conference room of Bldg 6025, and the participants will use their own laptops.

7. Accelerator Mass Spectrometry - production of atomic and molecular ions

Alfredo Galindo-Uribarri, Yuan Liu and Gerald Mills

Negative ions of various sample materials will be produced using a Cs sputtering source at the injector of the 25MV tandem electrostatic accelerator. The various atomic and molecular ions formed will be mass analyzed and their intensities measured with a Faraday cup and recorded. The samples will include ultra pure Cu produced at a deep underground facility in South Dakota SURF, isotopically pure 63,65Cu, and various forms of C, Si and Au. The sputtered flux contains agglomerates of several or many atoms. The mass spectra obtained will be analyzed offline using student's personal computer searching for odd-even effects and "magic numbers" in the emission/formation of large clusters. A brief discussion of long-lived radioactive ion production, beam purity, isobar separation, charge exchange and sputtering process will take place at the end.

8. Operation of an electromagnetic isotope separator

Dan Stracener and Jon C. Batchelder

The students will have the opportunity to operate an electromagnetic isotope separator to tune isotopically pure beams of Kr, Xe, and Sn to a Faraday cup. Using the known natural isotopic abundance, the relative intensities of the mass-separated beams can be used to identify the mass of the selected ions. We will use the OLTF (On-Line Test Facility), which is a basic isotope separator that has been used at the HRIBF to test targets and ion sources for the production of radioactive ion beams using the ISOL (Isotope Separation On-Line) production technique. The system is comprised of an ion source on a high voltage platform, an extraction system, an Einzel lens for focusing the extracted beam, electrostatic steerers, a dipole magnet with a resolving power (M/dM) of 2000, and beam diagnostics such as Faraday cups and a beam profile monitor. To gain a better understanding of RIB production targets and some of the ion sources that have been used at the HRIBF, hands-on displays of unassembled ion source parts and targets will be available during this session.