

## Idaho State University QuarkNet Activities for 2012

Idaho State University Department of Physics successfully completed its third year as a QuarkNet Student Research Center. Dr. Steven Millward, a physics teacher at Grace High School in Grace, Idaho, joined us for six weeks this summer to help mentor four high school students from June 11 through July 20. The students were Bryce Graham of Jerome, Idaho, and Erin Martin, Yoon-Su Ra, and Christina Wilmot of Boise, Idaho. They all worked on two or more projects in applied nuclear physics at the Idaho Accelerator Center. Research projects are summarized below:

### Focusing and Bending Magnet Construction

ISU is commissioning an off-axis bremsstrahlung beam facility which produces a linearly-polarized photon beam in the energy range of 1 to 15 MeV with a polarization of 30%. A new technique for detecting actinides is being investigated, which takes advantage of the unique angular signature of neutrons resulting from photofission through linearly polarized photons. In other words, a technique is being developed to use linear accelerators to detect nuclear material bad guys might try to sneak into the country to do us harm. The high school students helped in this work by continuing construction and testing of focusing and bending magnets for the electron beam line begun by QuarkNet students last summer. They used a lathe to wind the magnets, and machine tools to construct frames and housing. They used a Hall effect probe to map out the magnetic field of all four of the magnets they constructed. They compared these to the four constructed by QuarkNet students last summer to ensure consistency.

### Radiation Biology

The ISU radiation biology lab focuses on radiation effects in microbes, particularly the survival mechanisms employed by a wide variety of species. The model organisms we use come from all three kingdoms of life: bacterial (*E. coli*, *Bacillus* /sp., *Deinococcus radiodurans*/), archaeal (*Halobacterium* /sp.) and eukaryotic (*Schizosaccharomyces pombe*/ and *Dictyostelium discoideum*/). Through a series of irradiation/growth cycles, we have selected for "super-resistant" strains of *Halobacterium*/. Microarray analysis has shown that these strains are upregulated for a particular gene involved in basic DNA metabolism (replication, repair and recombination). QuarkNet students worked on further characterization of these strains through DNA sequencing analysis, cloning of mutant genes and moving the resistance gene from one strain to another. Interns also helped isolate strains of *E. coli*/ with enhanced survival with regards to temperature and salinity extremes. Last summer the students focused on survival with regards to radiation exposure. Unlike the *Halobacterial*/ strains, the *E. coli*/ strains started out deficient for a major DNA repair enzyme. This project involved identifying the gene(s) that are altered in the mutant strains, and attempting similar manipulations to the *Halobacterium*/ system.

Staff involved in mentoring, instruction, and supervision of the high school student interns were Professors Shropshire, DeVeaux, Wells, McNulty, Starovoitova, Dale, Forest, Harris, Lineberry, Barclay, as well as IAC Consultant Dr. Marcus Gagliardi and IAC Engineer Mark Balzer.

The eighth annual ISU QuarkNet Summer Institute was held June 18 - 22, 2012. QuarkNet veterans Mark Anderson of Boise, Idaho, Robert Franckowiak of Logan, Utah, Paul Shaber, of

Fruitland, Idaho, Dr. Steven Millward of Grace, Idaho, and Virginia Jones of Idaho Falls participated this year. During the institute, these Associate Teachers completed construction and testing of a new cosmic ray detector, and spent two days preparing, one day conducting, and one day evaluating data for an underground cosmic ray flux and attenuation experiment. We traveled to Minnetonka Cave on the Idaho-Utah border, and worked with National Forest Service employees to ensure safety and minimal environmental impact. Cosmic ray fluxes from detectors at different known depths within the cave were compared to fluxes measured on the surface directly above locations within the cave. Dr. Steve Shropshire directed the experiment with the assistance of Kris Whelan. The Associate Teachers uploaded data for analysis, and posted a report on the QuarkNet web site. They also prepared lesson plans for their schools to use with the cosmic ray detectors.

Lectures were given each day of the workshop. The topics were Current Research at the IAC, presented by Dr. Alan Hunt, The Standard model of Particle Physics, Frontiers in Particle Physics, and Extra Dimensions and String Theory (three lectures) by Dr. Steven Millward, and the Fukushima Nuclear Incident by Dr. Eric Lineberry.

During the Fall of 2011 and spring of 2012, eight cosmic ray detectors were shared between all ten of the Associate Teachers who participated in the 2011 Summer Institute. Each teacher used a detector for at least sixteen weeks to introduce their students to particle physics. All five of the Associate Teachers who participated in the 2012 Summer Institute will use either one or two of the nine ISU detectors in this fashion in the fall of 2012 and spring of 2013.