Montgomery College Students Attended the GW IRES Program

The following Montgomery College students have participated in the GW IRES Program.

Daniel Albuquerque – Engineering & Computer Science Major

Irina Koltsova - Engineering Major

Edward Chinn - Chemistry Major

John Ajamian,- Engineering Major

The GW IRES (International Research Experience for Students) Program supports undergraduate and graduate students to spend their summer in Germany and receive training and gain experience in modern detection systems, data acquisition systems, analysis of experimental data, and analysis and interpretation of the results of these experiments. Students work in an international experimental nuclear physics research program in the Crystal Ball and TAPS Collaboration Program at the Mainz Microtron (MAMI) within the Institut für Kernphysik of the Johannes Gutenberg University in Mainz, Germany. The program is open to students from many universities and colleges and it is sponsored by NSF.

Program's website: https://gwuires.wordpress.com/

Program's facebook page: https://www.facebook.com/SummerResearchInMainz.

Projects Descriptions

Further Development and Extension of EPICS Slow Control
Student: Daniel Alberquerque
The slow control system (control and monitoring for things like high voltages, gas systems, detector positioning etc) for A2 has been implemented in EPICS, a commercially available software package used at many different laboratories around the world. The pressure and flow sensors in the A2 gas Cherenkov detector were not yet set up to be remotely read out and monitored using EPICS. Daniel's project involved reading the pressure and flow sensor analogue outputs into a digital system using a Jeenode controller and an ADC. He then wrote the necessary code to control and read out the sensors using a small raspberry pi computer and incorporated the new slow control elements into the EPICS slow control system. Such slow control systems are also employed in industry.

Extrapolation of Data
Student: Irina Koltsova
Data taken at nuclear physics laboratories is measured at specific kinematic (energy and angle) settings determined by the properties of the accelerator and detector systems. This means that data sets taken at different laboratories or with different experimental setups, may not be directly comparable. Irina's project was to write some software that, given a set data set at specific kinematic points, could interpolate the data to other kinematic points to facilitate comparison between experimental data sets. She wrote a program, in the C++ programming language, which took an existing data set as input and evaluated the experimental data at different energies and angles, even calculating the errors in an appropriate manner.

Design and Construction of a Neutron Detector Assembly Frame:
Student: Edward Chinn
The A1 collaboration in Mainz want to measure the form factor of the neutron with unprecedented accuracy. To do so, they need to develop plastic scintillator arrays to detect scattered neutrons. This project was to design a frame in which the long scintillator bars could be safely held for gluing and assembly, which would hold them firmly, without damaging them, but allow the necessary access to glue light guides and photomultipliers at both ends. The project began by examining several anomalous structures and investigating standard technologies available. Rough designs were then designed and sketched, until a concept was agreed upon by the group. The selected concept: a lockable double frame which allows the internal frame to rotate in order that both ends can be accessed and worked upon was then designed in Autodesk Inventor. The CAD drawings were given to the Mainz mechanical workshop, who constructed the components. They were then assembled and a first scintillation detector was manufactured within the frame as proof of concept, and then tested. The scintillation detector was successfully constructed and functioned well without damage. The frame will now be used to manufacture the necessary scintillator bars.

Crystal Ball Live Display
Student: John Ajamian
In this project John worked together with Brendan Gallagher (George Mason University) and David Plotnick (George Washington University)

The A2 collaboration of the Institute for Nuclear Physics of Johannes Gutenberg University performs research on (multiple) meson photoproduction and nucleon structure and dynamics using a polarized photon beam on unpolarized targets, such as liquid hydrogen and deuterium, and heavier solid targets like carbon and lead. The also use polarized butanol and Helium targets. Particles scattered from the target are detected in the Crystal Ball (CB) and TAPS detector array. The CB detector system has inner detectors which give charged particle directions and identities, but the surrounding calorimeter, the Crystal Ball itself, is composed of 672 NaI crystals. The Crystal Ball provides particle energies and directions, for both charged and neutral particles. It covers the full azimuthal angle around the target and from 20 to 160 degrees in the polar angle. The aim of this project was to create a functioning replica of the CB that could display in real time, events detected in the CB during experimental running, for outreach and debugging purposes. Outside of beam time, it could be used to replay and visualize experimental and simulated data, and also to analyze the calibration settings of the Crystal Ball, to help understand any systematic effects.

The replica was designed to be 3D printed, however, due to technical issues, it was constructed using two Plexiglas hemispheres. The 672 crystals were represented by programmable LEDS which could be addressed using an Arduino and Raspberry Pi, and powered by a separate power supply. Holes were drilled for each of the 672 LEDs, and the LEDs were glued into place, mapped and addressed in software, and a program was written to allow live and accurate representation of events. The AutoCAD designs for the 3D printed version were completed, prototyped and demonstrated to function well, so it is planned that further versions of the CB model will be manufactured using the designs and software prototyped in this initial model.

The color and brightness settings of the LEDs can be used to represent particle types and energy deposits, and the timing capability also allows one to display the development of e.g. an electromagnetic shower in time.

Presentations

D. Albuquerque, *Cherenkov Detector Incorporation into EPICS*, Talk, International Research Experience for Students Symposium, George Washington University, Washington, DC, November 2015

D. Albuquerque, *Cherenkov Detector Incorporation into EPICS*, Talk, A2 Collaboration Summer Research Presentations, Johannes Gutenberg University Institute for Nuclear Physics, Mainz, Germany, July 2015

I. Koltsova, *Data Interpolation for Single-Energy Partial Wave Analysis*, Talk, International Research Experience for Students Symposium, George Washington University, Washington, DC, November 2015

I. Koltsova, *Data Interpolation for Single-Energy Partial Wave Analysis*, Talk, A2 Collaboration Summer Research Presentations, Johannes Gutenberg University Institute for Nuclear Physics, Mainz, Germany, July 2015

J. Ajamian, *Designing the Crystal Ball 3D Replica,* Talk, A2 Collaboration Summer Research Presentations, Johannes Gutenberg University Institute for Nuclear Physics, Mainz, Germany, July 2016

J. Ajamian, *Designing the Crystal Ball 3D Replica,* Talk, International Research Experience for Students Symposium, George Washington University, Washington, DC, November 2016

E. Chinn, *Optimizing the Construction of the A1 Collaboration Neutron Detector*, Talk, A2 Collaboration Summer Research Presentations, Johannes Gutenberg University Institute for Nuclear Physics, Mainz, Germany, July 2016

E. Chinn, *Optimizing the Construction of the A1 Collaboration Neutron Detector*, Poster, APS CEU Conference, Vancouver, Canada, October 2016

E. Chinn, *Optimizing the Construction of the A1 Collaboration Neutron Detector*, Talk, International Research Experience for Students Symposium, George Washington University, Washington, DC, November 2016