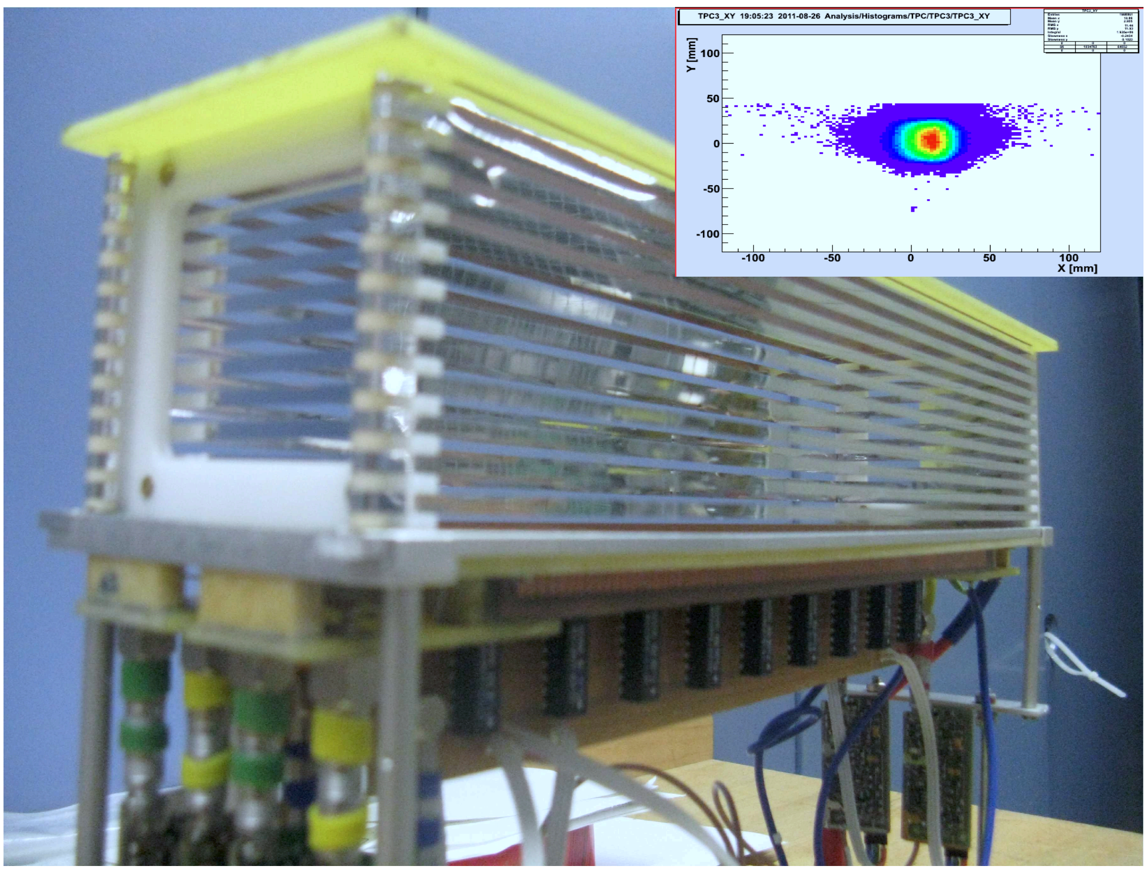
Eighth Annual Undergraduate Mini-Symposium

Department of Astronomy and Physics
Saint Mary's University
Friday September 9, 2011, Sobey 260



Time projection chamber: A visualization tool used for particle trajectories (as shown in inset) (Andrej Prochazka, Atkinson)

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The Department of Astronomy and Physics

The Office of the Dean of Science

Eighth Annual Undergraduate Mini-Symposium

Friday September 9, 2011, 10:00 am – 2:00 pm

Sobey 260

Programme

Opening remarks (Clarke)			10:00 – 10:10
1	J. Campbell (Sarty, Sharpe)	*Research and development for a scintillating fibre coordinate detector for high-energy electrons*	10:10 – 10:30
2	R. Campbell (Sarty)	*A reaction-yield macro to support experiment planning with high-energy gamma rays at the Mainz Microtron*	10:30 – 10:50
3	D. Robertson (TITAN, TRIUMF)	*An improved vacuum system for storing highly charged ions in a Penning trap*	10:50 – 11:10
4	J. Atkinson (Kanungo)	*Measuring the charge changing cross sections of neutron-rich isotopes*	11:10 – 11:30
5	G. Tomney (Kanungo)	*Observing* $^{11}Li(d,p)$ *reactions at TRIUMF with silicone detector arrays*	11:30 – 11:50
6	A. Valencik (Kanungo)	*Elastic and inelastic scattering of* ^{11}Li	11:50 – 12:10
Lunch (courtesy of the dean of science)			12:10 – 1:00
7	E. Campbell (Short)	*Synthetic Johnson Cousins colours for red giants*	1:00 – 1:20
8	W. Beslin (Deupree, Peña, Gallo)	*Oscillation spectra at rapid rotation*	1:20 – 1:40
Award presentations (Clarke)			1:50 – 2:00

Abstracts

1. *Research and development for a scintillating fibre coordinate detector for high-energy electrons*

Jessica Campbell (Sarty, Sharpe)

This presentation will provide an overview of the design and technical considerations required to build a scintillating fibre "coordinate locator" detector system for the BigCal detector in Hall A at Jefferson Lab (a nuclear physics research facility in Virginia operated by the US Department of Energy). The first consideration in the design phase was to gather the technical requirements associated with the operation of the detector system. These specifications were then used to research alternative options for identifying equipment and components necessary to build such a detector system. Furthermore, the options analyses looked at what could be done using local resources in order to control overall costs. At the end of this research initiative, a first-draft proposal, that includes technical drawings and specifications for the "coordinate locator" detector system, was produced. This work was performed in parallel with other lab duties that provided orientation and hands-on experience with detector system technologies associated with using and testing scintillating fibres; this resulted in the construction of a small, thin plastic scintillator to support ongoing graduate research in this area being carried out by my in-lab supervisor, Jason Sharpe.

2. *A reaction-yield macro to support experiment planning with high-energy gamma rays at the Mainz Microtron*

Rebecca Campbell (Sarty)

This presentation reports on summer research activities in Mainz, Germany, at the Nuclear Physics Institute of the Johannes-Gutenberg University. The Institute houses a race-track microtron known as the Mainz Microtron (MAMI). The microtron accelerates electrons, producing a beam with energies up to 1.5 GeV. This research project was with the "A2 Collaboration", focusing on investigations of high-energy gamma-ray interactions with the proton; specifically meson production and Compton scattering. The complex detection system in A2 is comprised of two primary gamma-ray detector arrays—the Crystal Ball (CB) and the Two-Arm Photon Spectrometer (TAPS)—with two charged-particle systems embedded in the CB (a Particle Identification Detector, and a Multi-wire Proportional Chamber). This detector system measures the amount of energy deposited by the reaction products as well as their charge, and tracks their position.

The specific summer research project reported here was the development of a "Root" software macro to help with experiment planning by providing a prediction of the yield rates for certain experiments (either Compton scattering or neutral pion photoproduction from the proton). These calculations account for beam energy and current, target type and thickness, reaction cross-section (provided from previous experiment or theory), the effective electron count …

3. *An improved vacuum system for storing highly charged ions in a Penning trap*

Damien Robertson (TITAN, TRIUMF)

The TITAN facility at TRIUMF relies on ultra high vacuum environments to be able to accurately conduct mass measurements on highly charged radioactive isotopes. The research facility uses a Penning trap, which is capable of measuring mass with a relative uncertainty of $\delta m/m \approx 10^{-9}$. However, in low quality vacuum environments these ions can be compromised due to charge exchange. The aim of the first part of this work is to investigate a way to implement an ionization pump, which is capable of creating and sustaining ultra high vacuum. The second part of this work investigated the interference of an ionization gauge with an MCP detector, which is used for mass measurements. This ion gauge will be essential to properly interlock the Penning trap's vacuum chamber in case of a vacuum failure. A device was designed and tested which will mitigate unwanted charged particles emitted from the ion gauge that interfere with the MCP detector.

4. *Measuring the charge changing cross sections of neutron-rich isotopes*

Joel Atkinson (Kanungo)

The neutron-rich isotopes in the nuclear chart are displaying characteristics that cannot be explained by traditional nuclear models. The concept of nuclear models had to be redefined due to exotic forms of nuclei such as nuclear halo and skin. These unexpected structures put forth many important questions. A particularly interesting topic is to study how the proton radii change as we go to neutron-rich isotopes. This study is also expected to provide information on neutron skin thickness for such neutron-rich isotopes.

In my presentation, I will provide a description of the experiment that was conducted this summer at GSI, Darmstadt Germany to determine the proton radii through a measurement of the charge changing cross section. I will describe how the fragment separator FRS was used for this experiment. I will also discuss the roles of the Time Projection Chamber (TPC) in this measurement.

5. *Observing ^{11}Li(d,p) reactions at TRIUMF with silicone detector arrays*

Greg Tomney (Kanungo)

The rare isotope ^{12}Li was produced and observed at TRIUMF. The production of ^{11}Li using the cyclotron at TRIUMF will be discussed as well as the ^{11}Li(d,p) reaction wherein ^{12}Li is produced. I will explain the physics of the Silicone detectors used to measure the energy of incident particle collisions. Also, the benefits of a different detector array configurations will be discussed with respect to real observed angles in our experiment.

6. *Elastic and inelastic scattering of ^{11}Li*

Andrew Valencik (Kanungo)

^{11}Li is a very neutron-rich isotope that exhibits an unusual halo structure. A nuclear halo is formed by two outer neutrons that are weakly bound to the ^{9}Li core. This structure raises important questions about the formation of nuclear halos and their interactions with other matter. A particular interest is in the nuclear interaction potential of ^{11}Li with stable targets which are used for experiments. I will discuss the further analysis of a 2010 ^{11}Li + p scattering experiment, conducted at TRIUMF. One of the aims of this analysis is to extract the optical potential of ^{11}Li + protons.

The calculation of kinematics for various reaction paths will be discussed and compared to experimental data. These kinematics are needed in order to tell what reaction path a particular event corresponds to. The ability to separate reactions is necessary for further analysis such as measuring the cross section of the various reactions. The kinematics also help in calculating the excitation energy of inelastic scattering. This information is crucial in the search for excited states of ^{11}Li.

7. *Synthetic Johnson Cousins colours for red giants*

Eamonn Campbell (Short)

We apply Johnson-Cousins photometric filters to Phoenix synthetic spectra computed in LTE and non-LTE to determine the synthetic $U - B$, $B - V$ and $V - R$ colour indices. These indices were calculated over a temperature range simulating red giant stars (4000 – 5500 K) and displayed on both two-colour and colour-temperature plots, and over-plotted with data from the catalogues of Mermilliod (1994), Lanz (1986) or the the Bright Star catalogue, 5th Ed. All three indices showed similar trends to that of the catalogue data for the least-reddened stars. We confirm that decreasing metallicity, increasing gravity and increasing effective temperature all result in greater blue flux with respect to red flux, and consequently lower colour indices. We found that non-LTE effects also increase the blue to red flux ratio, and thereby lower the UB and $B - V$ indices by approximately 0.1 and 0.02 magnitude, respectively.

8. *Oscillation spectra at rapid rotation*

Wilfried Beslin (Deupree, Peña, Gallo)

We have computed axisymmetric p mode oscillation frequencies and eigenfunctions for 2.25 $M_{\odot}$ ZAMS models of different uniform rotation speeds. The surface equatorial velocities vary from 0 to about 200 km/s. The frequencies were calculated for values of the number of radial nodes (n) from 10 to 20, and the individual modes were tracked through the entire rotation sequence. The change of both the pulsational frequencies and the surface behaviour of the displacement perturbations with rotation are discussed. It was found that the large separation does not change very much with rotation, at least for rotation rates included, while the small separation increases substantially as the rotation rate increases. It was also apparent that tracking of the modes based on surface displacement becomes increasingly difficult with higher rotation speeds.

In addition, I have developed a web site for Dr. Luigi Gallo about the Astro-H X-ray mission, of which a brief tour will be given.