The Testing of Hall D Beam Position Monitors For Operation On a Low Current Beam.
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Efficient accelerator operation requires the determination of the electron beam position at various locations along the beam path. The Jefferson Lab Beam Position Monitors (BPMs) are superheterodyne receivers that utilize analog and digital components. The BPMs measure the voltage and phase of the beam and utilize these measurements to determine the position and change in position of the beam, respectively. Hall D requires more sensitive stripline BPMs, which can detect low-current beams. The focus of this project was to test stripline BPMs, before installation. Furthermore, the BPM firmware and new methods of BPM calibrations, including phase measurement calculations and Y-factor calibration, will be tested before utilization in the beam tunnel. To test the BPMs, a Goubau Line system was used to simulate an electron beam. The BPMs were attached to Stac6Si stepper motors, which were used to scan a 1 cm^2 area around the BPM center. The stepper motor position was compared with the BPM data to measure BPM sensitivity. Finally, the BPMs' circuitry and Y-factor calibration methods were tested. It was found that BPM voltage measurements can determine the beam's position with a sensitivity of 1.9 dBm/mm. Furthermore, Y-factor analysis provided real-time measurements of BPM gain and noise factor. The BPM circuitry was found to have an acceptable gain, isolation, and saturation point. It was determined that a 1 mm change in position results in a 4.2° change in phase. It was found that the new BPMs are twice as sensitive as previous models, and, with the use of a perceptron, phase measurements can determine change in beam position, providing feedback for beam operators during BPM calibration. More sensitive position measurements allow researchers to conduct experiments requiring low-current beams, and allow for more accurate electron beam positioning.

Target Mass Corrections to Nucleon Structure Functions. **MATTHEW D. BROWN** (Arizona State University, Tempe, AZ 85287) WALLY MELNITCHOUK (Thomas Jefferson National Accelerator Facility, Newport News, VA 23606).

A nucleon (a proton or a neutron) can be described simply as a bound state of three quarks. However, in reality, the structure of the nucleon is complicated by the gluons which bind the quarks together and quark-antiquark virtual pairs popping in and out of the vacuum. This structure is often parameterized by quantities known as structure functions. Structure functions are measured in deep inelastic scattering experiments with nucleon targets, such as the ones conducted here at Jefferson Lab, and then fitted to theoretical conjectures. Because of the high energies involved in the experiments, one may typically assume when postulating theoretical parameterizations that the nucleon mass is negligible compared to the interaction energy. However, in order to obtain a more accurate and complete picture of the internal structure of nucleons, we considered the effects of target mass corrections to nucleon structure functions. Using the operator product expansion of quantum field theory, along with several other mathematical tools, we obtained elegant new formulas for the target mass corrections to all of the usual spin-averaged nucleon structure functions. We also determined the Cornwall-Norton moments of each target mass corrected structure function, quantities which are convenient for numerical studies. Our results are consistent with previous work. However, we have found interesting behavior of the target mass corrected structure functions in what is referred to as the large-*x* regime. This suggests a relationship between our work and what is known as the threshold problem, one of the most important outstanding questions about the limitations of the operator product expansion.

Slow Controls LabVIEW Program for the Silicon Vertex Tracker. MINNAE P. CHABWERA (Hampton University, Hampton, VA 23668) AMRIT YEGNESWARAN (Thomas Jefferson National Accelerator Facility, Newport News, VA 23606).

The focus of this project was to create a LabVIEW slow controls program for the Silicon Vertex Tracker, SVT, slow controls system. The program will be used to test the modules of the SVT at Fermi National Accelerator Laboratory, Fermilab. The LabVIEW Virtual Instrument, VI, in which the program was created and is currently stored, will run a 72-hour burn-in test on each of the 66 modules of the SVT, while retaining the ability to run shorter, more specific tests. The slow controls VI has been designed for both novice and expert LabVIEW users, while allowing them the freedom to adjust the parameters specifically to their needs. The VI was created with the capability to run with voltage and current as its parameters. The graphical user interface, GUI, of the LabVIEW slow controls program is designed with a user-friendly interface, where each parameter control is labeled and easy to accurately adjust. The main result from the LabVIEW program is the creation of the monitoring program for the detector modules. The VI has been programmed to communicate with the MPOD hardware, make a strip chart of the voltage and current levels, and automatically record data. It has been specifically wired in the block diagram for the computer to communicate with the MPOD crates and resultantly the SVT. The LabVIEW slow controls program reads back the voltage and current from each channel, as well as signals the voltage and current relation to the programs' threshold settings. The results have been a VI that uses voltage and current as its primary parameters and communicates directly to the MPOD hardware. The next steps for the LabVIEW program to be used in Hall B will be the conduction of the burn-in test and expansion to include more parameters such as humidity and temperature.

Development of a Slow Controls Program for the Silicon Vertex Tracker. KALEE M. HAMMERTON (Christopher Newport University, Newport News, VA 23606) AMRIT YEGNESARWAN (Thomas Jefferson National Accelerator Facility, Newport News, VA, 23606).

As part of the 12 GeV Upgrade to the Continuous Electron Beam Accelerator Facility (CEBAF) Large Acceptance Spectrometer (CLAS) in Hall B of Thomas Jefferson National Accelerator Facility, the Hall B Instrumentation group is developing a silicon vertex tracker (SVT). The SVT requires that each of its 66 modules be connected to four low-voltage and two high-voltage channels. The voltage will be provided to the SVT by Wiener MPOD mainframes. These mainframes hold low- and high-voltage cards, which have eight and 16 channels, respectively. The objective of this work was to develop a LabVIEW program to set and adjust the voltages and to monitor the set voltages and the current drawn by the detector. The program was built up from the simple network management protocol (SNMP) virtual instruments (VI) provided by Weiner for LabVIEW. A graphical user interface was designed to allow novices and experts to operate the program. The initial program is capable of setting the voltages and reading back the voltages and currents from eight low-voltage channels and 16 high-voltage channels. The program is communicating with the MPOD mainframe and is running error free. The program will be used for the burn-in tests that will be conducted on the modules at Fermi National Accelerator Facility in the fall of 2012. Now that one card worth of low-voltage and of high-voltage channels can be set, changed and monitored, the program can be easily expanded to set and monitor the 264 low-voltage channels and the 132 high-voltage channels needed for the SVT.

Electromagnetic Field Distribution Measurements in a New Deflecting/Crabbing SRF Cavity Using a "Bead Pull" Test. YOAV LEVINE (Tel Aviv University, Tel Aviv, Israel 69978) JEAN DELAYEN (Thomas Jefferson National Accelerator Facility, Newport News VA).

The Continuous Electron Beam Accelerator Facility (CEBAF) at Jefferson Laboratory and the Large Hadron Collider (LHC) at Conseil Européen pour la Recherche Nucléaire (CERN), present a need for a deflecting/crabbing cavity. At LHC, this cavity will rotate the beam bunches just prior to collision in order to enhance the luminosity, and at CEBAF this cavity will deflect each bunch to its corresponding experimental hall. A superconducting radio frequency (SRF) deflecting/crabbing cavity was designed and two niobium models were manufactured, one for each facility. Their geometry is designed to allow an optimal electro-magnetic (EM) field distribution, most importantly a horizontal electric field and vertical magnetic field on the main axis. The focus of this project was to measure the actual EM field distribution inside the cavity intended for CEBAF and to track deviations from the numerical simulations conducted prior to its manufacturing. A "bead pull" measurement was conducted, based on the principle stating that when a dielectric or metallic small bead is inserted into a cavity, it perturbs the EM field, causing the resonance frequency of the cavity to shift. A designated LabVIEW program was modified to coordinate measurements of the cavity's phase shift as beads of different materials and shapes were pulled through it. It was found that the measured on-axis horizontal electric field distribution is satisfactorily consistent with the simulations, exhibiting a symmetric peak of the expected width and magnitude. The on-axis magnetic field measurement demonstrates peaks at the expected positions, but was influenced by the bead over-perturbing the field and needs to be retaken. The off-axis longitudinal electric field measurement demonstrates peaks positioned further away from the center than predicted. Overall, it is shown that the CEBAF cavity exhibits the expected horizontal electric field response to radio frequency excitation, but needs further testing before ready to operate successfully at its intended facility.

Simulating Pressure Profiles for the Free-Electron Laser Photoemission Gun Using Molflow+. DIEGO MIONG SU SONG CHO (Wesleyan University at Middletown, CT 06459) CARLOS HERNANDEZ-GARCIA (Thomas Jefferson National Accelerator Facility, Newport News, VA).

The Jefferson Lab Free-Electron Laser (FEL) is capable of generating tunable infrared or ultraviolet laser light by passing a relativistic electron beam through a magnetic undulator. The electron beam is generated in a high-voltage DC electron gun with a semiconducting photocathode, which must be placed in stringent vacuum conditions, an imperative requirement in order to guarantee photocathode longevity. In prospect of an upcoming upgrade of the electron gun, this project consists of simulating pressure profiles to determine if the novel design meets the electron gun vacuum requirements. The method of simulation employs the software Molflow+, developed by R. Kersevan at the Organisation Européene pour la Recherche Nucléaire (CERN), which uses the test-particle Monte Carlo (TPMC) method to simulate molecular flows in three-dimensional structures. Using Molflow+, pressure profiles are obtained along specified chamber axes in the form of linear plots and color-mapped texture graphics. Molflow+ pressure profiles are then compared to measured pressure values in existing electron guns for validation. Outgassing rates, surface area, and pressure were found to be proportionally related. The simulations make evident that the upgraded gun vacuum chamber requires more pumping compared to the existing FEL electron gun vacuum chamber. Since experimental data correlates well with simulation results, the simulations predict that the new electron gun should have similar vacuum conditions to the existing one, with pressures ranging from 4.0×10^{-12} Torr to 4.5×10^{-11} Torr, depending on the outgassing rate after vacuum bake-out. The ability to simulate pressure profiles through validated tools like Molflow+ allows researchers to optimize complex vacuum systems during the engineering design process.

Simulation of the Hall C Compton Polarimeter Electron Detector. **ERIK G. URBAN (Hendrix College in Conway, AR 72034) DAVID GASKELL** (Thomas Jefferson National Accelerator Facility, Newport News, VA 23606).

Experiments at Thomas Jefferson National Accelerator Facility (TJNAF) use a polarized electron beam to make high-precision, electron helicity-dependant measurements in order to probe the fundamental properties of particles. In such experiments, knowledge of the electron beam polarization is required to extract the physics of interest and therefore needs to be tracked precisely. The Hall C Compton polarimeter serves this need by measuring the scattering asymmetry observed between helicity states in polarized Compton scattering. The primary objectives of this project are to update a simulation and analysis package for the electron detector used in the Compton polarimeter in order to better understand the processes influencing the beam polarization measurement, to test the validity of the current analysis methods, and to test for various systematic sensitivities within the apparatus. First, the simulation package was modified to include the current electron detector configuration and to output the necessary information from each event to a data file. Secondly, the analysis package was redesigned to receive this data and analyze it as if it were from a real experimental run. Once both systems were operational, slight systematic changes were made to the simulation but analyzed without accounting for them in order to gauge the systematic uncertainties associated with the beam polarization measurement as a whole. Both systems are currently functional and it is now possible to gauge the systematic uncertainties associated with the polarimeter. Once all of the tests on the simulation are complete, it will be known which method of analysis is most appropriate and which parameters have the largest impact on the overall uncertainty associated with the polarization measurement. With the uncertainty associated with the beam polarization determined, its overall impact on the final precision achievable by the Hall C experiments will be known.

Cresting Algorithm Using Fourier Analysis of Beam Position. RYAN ROUSSEL (Rensselaer Polytechnic Institute, Troy,NY,12180) YVES ROBLIN (Center for Advanced Studies of Accelerators, Thomas Jefferson National Accelerator Facility, Newport News,VA, 23606)

The Continuous Electron Beam Accelerator Facility (CEBAF) accelerator contains two linear accelerators with superconducting radio frequency (SRF) cavities to accelerate electrons. Sinusoidal electric fields are created inside the cavities, such that electrons see a constant potential accelerating them forward. For this to happen, the maxima of the electric fields in each cavity must be precisely matched to the timing of the particles trajectories. Unfortunately, when first starting the beam, imperfections in the accelerator prevent this from happening. Optimization is achieved by modulating the phase of cavities one at a time until the electrons are observed to have the maximum energy. The focus of this project is to improve the process of finding the crest (maxima) phase of multiple cavities by modulating a large number of cavities simultaneously. This was done by modulating the phase of each cavity at a different frequency and observing the position of the beam at a point of high dispersion. The position of the beam over the period of modulation was then Fourier transformed, producing spikes at the frequencies that corresponded to the different cavities. This was repeated with different amplitudes of modulation to fit a relationship between the amplitude of modulation and the Fourier transform spike amplitude, which contained phase information. This algorithm was used to determine the phase of cavities in a simulation of the North CEBAF Linac with an error of 100 microns in beam position measurement. The improved algorithm successfully predicted the correct phase of eight cavities simultaneously to within an error of two degrees. It has been shown that multiple cavities can be crested at the same time through the phase modulation of cavities at different frequencies and Fourier transforming the positions of the resulting beam. This has ramifications for accelerator operation, because it dramatically decreases tuning time needed for beam optimization.