High-rate Silicon Strip Detector for (e,e'K$^+$) Hypernuclear Spectroscopy

T. Miyoshi[a] and E89-009 collaboration

[a] *Department of Physics, Tohoku University*
Aoba-ku, Sendai, Japan, 980-8578

The hypernuclear experiment, E89-009, was carried out in Hall C at Jefferson Lab(Jlab). The momentum transfer and kinematics require that for a reasonable counting rate, the reaction particles must be observed at very forward angles. The hypernuclear spectrometer system used here, HNSS, employs a splitter magnet, placed at zero degrees after the target, allowing observation of electrons at zero degrees and kaons at about two degrees. At these angles the experimental data rates are limited by electron bremsstrahlung in the target, and therefore the electron spectrometer operates in a high flux of scattered electrons ($\approx 10^8\ s^{-1}$). A silicon strip detector was developed as a focal plane detector for a 300 MeV electron spectrometer (Enge Split-Pole Spectrometer, ESPS) and operated in such a high rate environment. Radiation dose was initially expected to exceed 50 kGy. Thus the SSD and its readout electronics was designed to withstand this dose and high count rate environment. The strip pitch was 500 μm, so that the corresponding energy resolution of the ESPS was better than 100 keV(FWHM), well below the contributions from the other elements of the HNSS. All together, 1440 SSD channels were required to cover the entire focal plane, resulting in the expected rate per channel of $\geq 10^5\ s^{-1}$. The signal pile-up in SSD can cause a loss of detection efficiency, so a readout system that can handle high-rates was necessary. To meet this requirement, only the digitized SSD hit information was fed to a multihit TDC through fast front-end electronics. Radiation damage of the SSD was closely monitored during the experiment by measuring noise rates and leakage currents. Since the SSDs received a charge of approximately 50 μC during 80 days of data acquisition, some of the SSD parameters, such as leakage current and noise level, changed. However, the SSD remained $\geq$ 95 % efficient throughout the experiment. This observation appears consistent with the expectation of significantly reduced non-ionizing energy loss in electron, as compared to heavy-projectile, irradiation.