

Using Lepton Pair Photo-production to Determine Beam Linear Polarization and Sensitivity to Nuclear RMS Charge Radii Using the GlueX Detector at JLab

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Abstract

We present measurements of linear photon beam polarization and studies of nuclear RMS charge radii via Bethe-Heitler lepton pairs using the GlueX detector at Jefferson Lab. Analysis of both e^+e^- and $\mu^+\mu^-$ pairs produced via $\gamma^{208}\text{Pb} \rightarrow \ell^+\ell^- (^{208}\text{Pb})$ provides complementary probes of beam polarization and nuclear charge distributions. The experiment utilizes data from the Charged Pion Polarizability program at Hall D, using neural networks with six multi-wire proportional chambers for μ/π separation and AI/ML techniques for e/π discrimination. Polarization measurements from azimuthal yield asymmetries in both leptonic channels agree well with triplet polarimeter measurements, with the $\mu^+\mu^-$ analysis representing the first muon-based polarimetry measurement. The Q^2 dependence of lepton pair production provides direct sensitivity to the nuclear charge form factor, enabling RMS charge radius extraction of ^{208}Pb . Comparison between electron and muon channels offers a unique test of radiative correction models under identical conditions. These complementary analyses establish a methodology for precision nuclear structure measurements, with future applications to compare electron and muon determinations of the proton charge radius. This work is supported by D.O.E. grant DE-FG02-88ER40415 A022.