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Citation for the original published paper (version of record):
Xarepe, M., Aumann, T., Blanco, A. et al (2023). Resistive plate chambers for precise measurement of high-momentum protons in short range
correlations at R³B. Nuclear Instruments and Methods in Physics Research, Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, 1055.
http://dx.doi.org/10.1016/j.nima.2023.168445

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Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment
Volume 1000, 21 March 2021, 165495

Sensitive plate chambers for precise measurement of high-momentum protons in short range correlations at JLab

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Abstract

The Reactions with Relativistic Radioactive Beams (**^{6}He**) collaboration of the facility for Antiproton and Ion Research (FAIR) has proposed a set of measurements in quasi-elastic proton knockout reactions in inverse kinematics at the Jefferson Lab, using a probe nucleus with exotic neutron-to-proton ratio, to study the nuclear structure, spectroscopic factors, and the nature of the nuclear forces in short range correlations (SRC). The reaction is equipped with neutron **^{6}He** and proton and recoilers **^{6}Li**, **^{4}He** and **^{3}He**, **^{3}He**, enabling a strong precision down to the kinematic resolution. The Jefferson Lab Hall A Tagged Deep Inelastic Scattering (TDIS) experiment, which is a part of the setup of the Hall A experiment that focused on measuring for the first time, in spring 2022, inclusive cross-sections of the reaction **^{4}He(e,e'p)^{3}H** in the SRC regime. The JPA tracking precision of the detector will allow the reconstruction of the 3-momentum of protons measurements with a resolution of around 1%. In beam measurements show an 8% and 3% resolution for the momentum and angle, respectively, with the current implementation of a reference accelerated and the momentum spread of the particles for forward oriented particles.

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Keywords

Radioactive Ion Beams; Timing; Time of flight; Resistive plate chamber; Short range correlations

1. Introduction

Short range correlations (the nuclear force acts on protons and neutrons inside a nuclear system is one of the hot topics in nuclear physics. At long distances, the attractive nuclear force is measurably well modelled by pion exchanges between nucleons. Nucleons are composed of quarks and gluons. At short distances, the nucleon substructure changes, requires, giving rise to the appearance of quarks and gluons and high-relative momentum (above the Fermi level), a phenomenon known as Short-Range Correlations (SRC)[1].

The characteristics of the timing nuclear force have been studied over the past years by the Jefferson Lab Collaboration (Jefferson Lab Hall A Tagged Deep Inelastic Scattering (TDIS) Collaboration, [2] a high-energy electron scattering experiment using stable targets. One of these most relevant results indicates that the fraction of high momentum nucleons is dominated by neutron-proton pairs (SRC). The Jefferson Lab Hall A experiment also indicating evidence in the description of high-momentum nucleons measurements the neutron-proton [3]. These correlation results are given directly connected to the charge-dependence of the nucleon-nucleon interaction. Nuclear-nucleon (NN) and nucleon-nucleon (NN) interactions.

An studies in stable nuclei do not allow to explore these effects at higher SLO values. A is mandatory to extend the effort towards studies of nuclear systems with large ratios of neutron-to-proton ratio. Such studies are available at JLab in the Jefferson Lab Hall A experiment, which is a part of the Tagged Deep Inelastic Scattering (TDIS) experiment.

Along this line, a first SRC study using neutron knockout was carried out at Dubna by the Baryonic Matter at Nuclotron based Iron Collider Device (MCD). (BM@N). The Baryonic Matter at Nuclotron (BM@N) is a fixed target experiment at JINR, which is a part of the NICA collaboration. The BM@N experiment is a fixed-target experiment