

Shandong University Application to CLAS12

Xiaqing Li

CLAS Collaboration Meeting

June 25, 2024



山东大学

SHANDONG UNIVERSITY



Shandong University (SDU)

Established in 1901

- Multiple campuses in Shandong province
 - Jinan (6 campuses) + Qingdao + Weihai
- Particle physics and nuclear physics
 - 1958 – First summer school on QFT in China
 - 1981 – First PhD granting program in high-energy particle physics in China
 - 2010 – Key Laboratory of Ministry of Education
 - 2018 – From Department of Physics (Jinan) to **Institute of Frontier and Interdisciplinary Science (Qingdao)**

**Welcome to SPIN2025 in Qingdao
to be hosted by SDU in Sep/Oct 2025**

June 25, 2024



Qingdao Campus (since 2018)



Xiaqing Li, SDU



Institute of Frontier and Interdisciplinary Science

Comprehensive particle and nuclear research groups!

3 Research Centers (62)

Particle Science and Technology (48)

Optics-Thermal Radiation

Space Science, Astronomy and Physics

Theoretical Particle Physics (11)

Medium-High Energy Nuclear Physics (11)

Accelerator Particle Physics and Software (12)

Non-Accelerator Experiments and Detection Technology (11)

Interactions between Particles and Matter (3)

- QCD (nucleon structure, heavy ion collision)
- Cosmology (BSM)
- Effective field theory

2008 	2019 	2023 	2023
1980 	1988 	1998 	2019
2006 	2006 	2009 	2009
			2022

- Plus:
- 35 graduate students per year since 2018
 - 40 undergrad students per year since 2022
 - 16 postdocs and 30 other staffs

(*Faculty numbers)



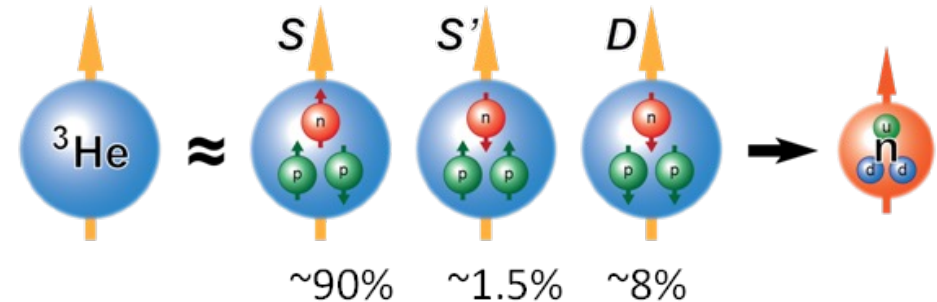
Medium-High Energy Nuclear Physics Group

- Xiaqing Li (CLAS12 term member under MIT since 2021)
 - 2020 Duke PhD (supervised by Haiyan Gao)
 - EIC YR: **New SIDIS generator and TSSA projections** (closely worked with Harut Avagyan)
 - 2021-2023 MIT postdoc (supervised by Richard Milner)
 - **R&D for CLAS12 polarized ^3He target** (closely worked with the JLab Target Group)
 - 2024 joined SDU in February as junior professor
 - Recruiting graduate students in fall and postdocs
- Weizhi Xiong on PRad and SoLID
- 9 other faculties on STAR@RHIC, among whom 3 for spin physics
- Potential foreign national faculty candidate to join SDU for JLab physics



Physics Interests at CLAS12 : Polarized ^3He in a High Magnetic Field

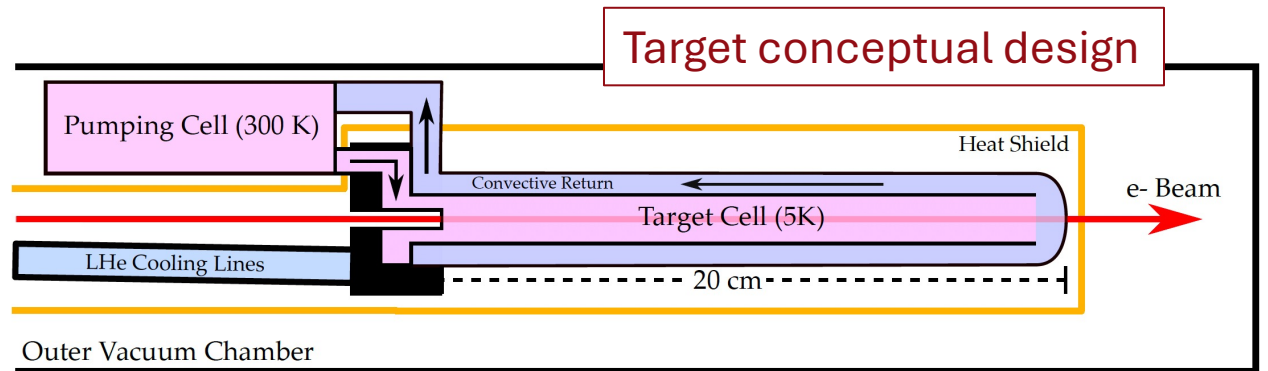
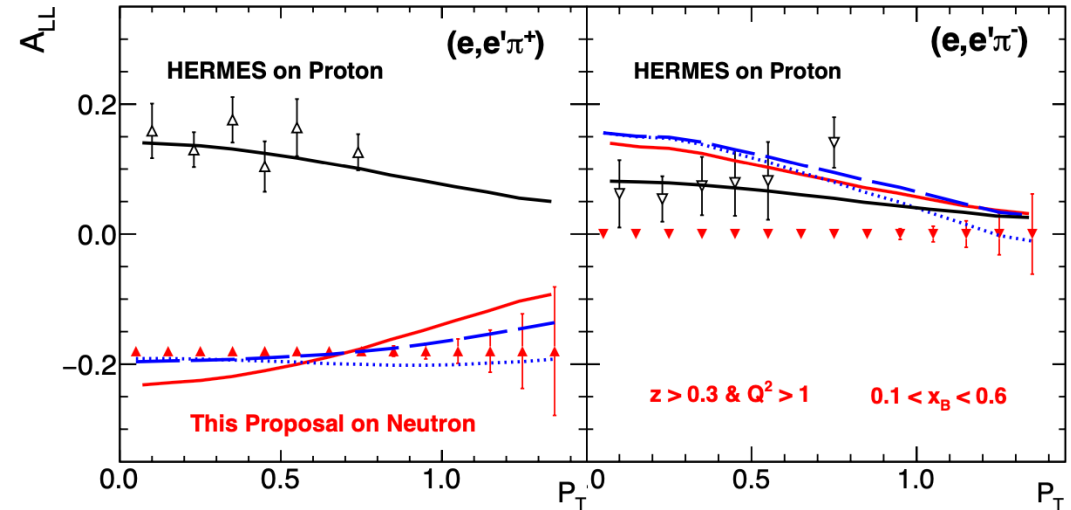
- Polarized ^3He : effective polarized neutron
 - 90% nuclear spin carried by the neutron
 - Neutron spin structure
 - Optical pumping methods
- Successful polarized ^3He targets in low magnetic fields in lepton scattering experiments
 - SLAC, HERMES, MIT-Bates, JLab 6 and 12 GeV (Hall A & C)
- New opportunities for polarized ^3He at CLAS12
 - Recent development on high-field metastability exchange optical pumping (MEOP) techniques
 - MIT-BNL efforts on polarized ^3He ion source for EIC





A program of spin-dependent electron scattering using a polarized ^3He target at CLAS12 (C12-20-002, Run Group N)

- Scientific opportunities
 - **SIDIS and nucleon spin structure**
 - Tagged DIS
 - Quasi-elastic scattering
 - Nuclear corrections to SIDIS
 - Deeply virtual exclusive processes
- Approved with A- conditionally on the novel polarized ^3He target development
 - J.D. Maxwell and R.G. Milner, Nucl. Instr. and Meth. A **1012**, 165590 (2021)
- 30 days of running at 10.6 GeV
- Spokespersons: H. Avagyan, J. Maxwell, R. Milner, D. Nguyen

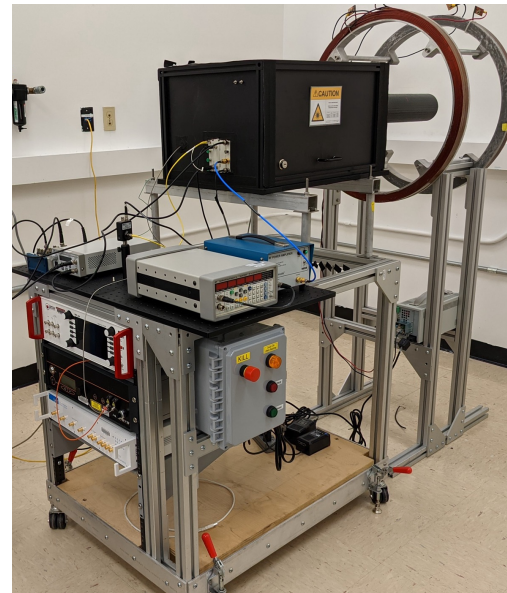




High-Field Polarized ^3He Efforts at CLAS12

- First ^3He polarization using MEOP at JLab
- Systematic studies of high-field MEOP

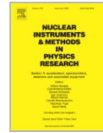
November 2021



December 2023



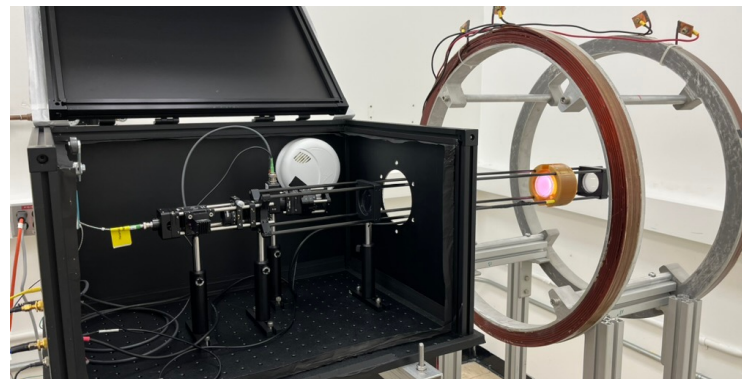
Nuclear Instruments and Methods in
Physics Research Section A:
Accelerators, Spectrometers,
Detectors and Associated Equipment
Volume 1057, December 2023, 168792



Full Length Article

Metastability exchange optical pumping of ^3He at low pressure and high magnetic field

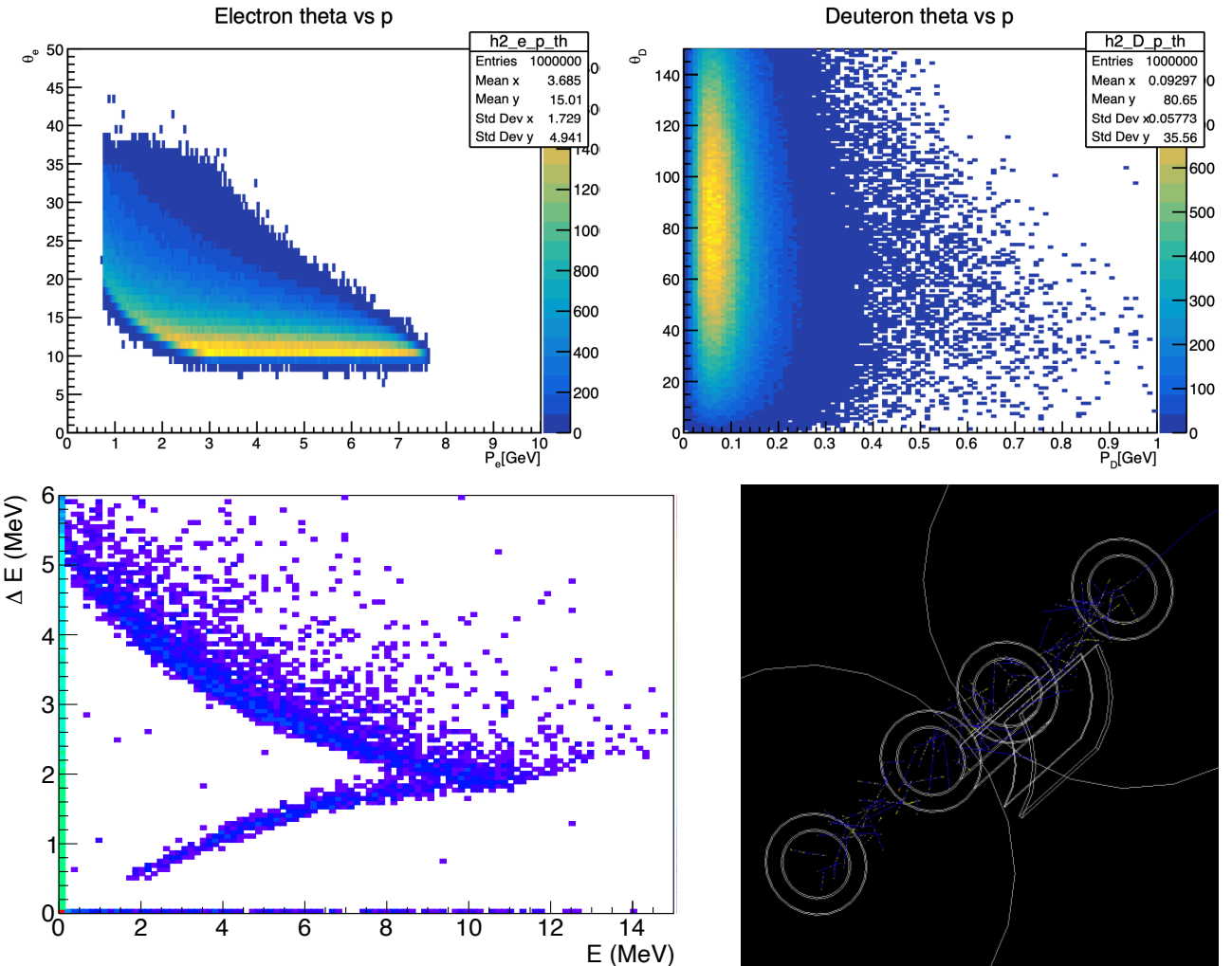
X. Li^a, J.D. Maxwell^b, D. Nguyen^b, J. Brock^b, C.D. Keith^b,
R.G. Milner^a, X. Wei^b





Future plan with polarized ^3He target at CLAS12

- Tagged DIS
 - Deuteron tagging measurement for proton DIS with ^3He
 - R&D for the deuteron detection system needs to be integrated with the double-cell target design
 - GEANT4 simulations on E- ΔE silicon telescope started
 - Aim to develop to full proposal for next coming PAC
- Quasi-elastic scattering
- Transverse polarization for ^3He at CLAS12





Summary

- CLAS12 large acceptance detection capability has great advantage in spin physics studies
- Development on the state-of-the-art techniques for optical pumping and polarimetry of polarized ^3He in high magnetic fields are underway at CLAS12
- SDU is looking forward to contributing to and enhancing the polarized ^3He program and other SIDIS programs at CLAS12 in the near future

Thank you!