Md Forhad Hossain

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Overview

I am a Postdoctoral Researcher at the University of Virginia and a Visiting Scientist at Fermi National Accelerator Laboratory, working on Experiments E906/SeaQuest and E1039/SpinQuest. My responsibilities include data analysis, software development, and hardware maintenance. I am a former officer at the Fermilab Student and Postdoc Association, where I advocated for young physicists.

Research Experience

• ***Leading the effort for the polarized target system and analysis in the SpinQuest Experiment at Fermilab.*** (May 2024 - Present) Advisor: Dr. Dustin Keller, University of Virginia, Charlottesville, VA

- Serving as an onsite expert for the cryogenic system in the SpinQuest experiment.
- Working on building the AI tool and performing data analysis for the experiment.

• ***Leading the trigger-detector effort for the SpinQuest Experiment at Fermilab*** (May 2018 - Present) Advisor: Dr. Stephen Pate, Dr. Vassili Papavassiliou, New Mexico State University, Las Cruces, NM

- Served as an onsite expert for hardware installation and NIM-electronics-based trigger detectors in the SpinQuest experiment.
- Developed software in Python and C++ and analyzed data to optimize high-voltage PMTs.

• ***Analyzing SeaQuest Experimental Data*** (Feb 2022 - Present) Advisor: Dr. Stephen Pate, New Mexico State University, NM

- Extracted angular distributions of proton-induced Drell-Yan dimuons at SeaQuest/E906, Fermilab.
- Used Geant4-based simulations for closure tests.
- Implemented the Bayesian Iterative Data Unfolding technique using RooUnfold software and applied machine learning methods to calibrate the simulated data for the Ph.D. thesis dissertation.

Education

Ph.D. in Physics, New Mexico State University, Las Cruces, NM, USA — August 2016 - May 2024
Supervisor: Dr. Stephen Pate

M.Sc. in Physics, New Mexico State University, Las Cruces, NM, USA — May 2021
Supervisor: Dr. Stephen Pate

M.Sc. in Physics, Jagannath University, Dhaka, Bangladesh — 2012 - 2014

B.Sc. in Physics, Jagannath University, Dhaka, Bangladesh — 2006 - 2012

Job Experience

Postdoctoral Research Associate June 2024 - Present
University of Virginia, Charlottesville, VA

- Leading the effort in the polarized target system, responsible for both hardware and software.
- Developing machine learning/AI tools for the experiments and analysis.

Graduate Research Assistant May 2018 - May 2024
New Mexico State University, Las Cruces, NM

- Conducted simulation tasks and developed the analysis framework for my thesis project.
- Served as an expert on the trigger detector system in the ***SpinQuest Experiment.***

Graduate Teaching Assistant Aug 2016 - May 2018
New Mexico State University, Las Cruces, NM

- Instructed introductory physics laboratory classes and provided tutoring as a Graduate Teaching Assistant.
- Played a role in networking and system administration.

Machine Learning Based Projects

- Neural Resampler for Monte Carlo.
  - A demonstration of unbinned reweighting of the simulated data based on neural networks.
- Reweighting MC distributions using Gradient Boosted Reweighter.
  - The purpose of reweighting the simulated events is to ensure that the simulated data closely matches the distributions observed in the real data.
- Uncertainty Quantification of the image segmentation using U-Net and MC dropout (Ongoing).

Collaborations

- ***SpinQuest***

The E1039/SpinQuest experiment will measure the Sivers function of sea quarks using the 120 GeV proton beam and polarized NH_3 and ND_3 cryogenic targets.

- ***SeaQuest***

Fermilab E906/SeaQuest measured the Drell–Yan cross-section ratio of proton-deuterium to proton-proton to determine the antiquark flavor asymmetry $\bar{d}/\bar{u}$ in the proton. The experiment will also measure the angular distributions from the Drell-Yan process.

Professional Memberships

- ***American Physical Society (APS)***

Technical Skills

Bash, C++, Python, ROOT, GitHub, PyTorch, TensorFlow, Linux, Geant4, LaTeX.

- ***Special Courses and certifications***: 1) U.S. Particle Accelerator School (USPAS) 2) DANCE/CoDaS computational and data science software training 3) The 2023 National Nuclear Physics Summer School (NNPSS)

Journal Publications

1) CH Leung et al. Measurement of J/ψ and $\psi\,(2S)$ production in $p+p$ and $p+d$ interactions at 120 GeV. 2024, arXiv:2302.04152
2) Stephen Pate et al. Estimation of Combinatoric Background in SeaQuest using an Event-Mixing Method. 2023, arXiv:2302.04152
3) Andrew Chen, et al. Probing nucleon's spin structures with polarized Drell-Yan in the Fermilab SpinQuest experiment. 2019, arXiv:1901.09994
Lists of SeaQuest and SpinQuest Collaboration Papers and Conference talks in my Google Scholar profile:

https://scholar.google.com/citations?user=KOygUhMAAAAJ&hl=en.

Invited Talk

1) New Perspectives, 08-09 July 2024, Fermi National Accelerator Laboratory, Illinois, Chicago, USA : SpinQuest in 10 Minutes.

Presentations

1) 2023 Fall Meeting of APS DNP and JPS : Angular Distribution of Dimuons from Drell-Yan Production in p+Fe Interactions at 120 GeV Beam Energy
2) New Perspectives, 26-27 June 27 2023, Fermi National Accelerator Laboratory, Illinois, Chicago, USA: Iterative Unfolding of the Angular Distribution of Drell–Yan Production in p+Fe Interactions at 120 GeV Beam Energy
3) Fall 2022 Meeting of the APS Division of Nuclear Physics, October 27-30 2022: Measurement of the Angular Distribution of Drell-Yan Production in p+Fe Interactions at 120 GeV Beam Energy
4) New Perspectives, 16-19 August 2021, Fermi National Accelerator Laboratory, Illinois, Chicago, USA: Transverse single spin asymmetry in J/ψ Production in $p\vec{p}$ interactions at SpinQuest
5) 2020 Fall Meeting of the APS Division of Nuclear Physics, October 29-November 1, 2020: Systematic Study of Potential False Azimuthal Asymmetries in SpinQuest
6) New Perspective 2020(2.0), August 24-25, 2020: Systematic Study of Spectrometer-Induced Azimuthal Asymmetries for SpinQuest
7) Summer 2019 USPAS Session: 350 MHz Single Spoke Resonator design and optimization for β =0.45
8) 52nd Fermilab Users Organization Annual Meeting, Batavia, IL, USA: Commissioning Trigger for the SpinQuest/E1039 Experiment (**Poster**).

Leadership Roles

- Judge at the Southwestern New Mexico Regional Science and Engineering Fair — March 2017
- FSPA Officer at the Fermilab Student and Postdoc Association (FSPA) — Oct 2021 - Oct 2022

Honors and awards

2022-2023	$4000 Merit-based Enhancement Fellowships.
2021-2022	$1600 Scholarship for outstanding work as Ph.D. student.
2021-2022	$2962 IA HEERF PHYS LEADS 2025.
2020-2021	$1600 Scholarship for outstanding work as Ph.D. student.

Media Appearance

- NMSU continues research on particle physics with renewed DOE grant — July 09, 2022
- NMSU physics department awarded $1.26 million DOE grant — June 23, 2018