I would like to first thank the JSA/JLab Graduate Fellowship Program committee for awarding me this fellowship. Over the course of my JSA/JLab fellowship of 2018–2019, I worked on various aspects of the GlueX DIRC detector.

Simulation

There had been a lot of simulation efforts to ensure we described the DIRC detector as well as we could before receiving the first commissioning data. I played a major role in the implementation of the DIRC detector into the GlueX simulation framework, with special attention paid to ensuring the realistic as-built geometry was faithfully represented in the simulation. I also led the effort to integrate the survey and alignment data into the simulation after the DIRC was installed and surveyed for commissioning.

As part of the optical expansion volume design, an LED calibration system was put in place to provide diagnostics of the photosensors and to determine per-pixel timing calibration. I implemented this LED calibration system in the GlueX simulation framework and performed studies to make sure we could achieve the needed precision for the timing calibrations.

Installation and Commissioning

A so-called “cookies” technology was developed to increase the photon yield of the DIRC detector. It is a layer of custom-made silicone material to be placed between the photosensors and the photon exit window of the optical expansion volume. I participated in the production of these silicone cookies at the MIT Bates Laboratory. Later at Jefferson Lab, I installed the PMT arrays together with those silicone cookies.

During the February 2019 commissioning run, I played an important role in the data quality monitoring and analysis efforts. Such efforts ensured that we obtained good quality commissioning data for the subsequent in-depth offline analysis. I also participated in the run planning and led various special-task runs during commissioning data taking.

Reconstruction and Commissioning Data Analysis

Due to the nature of such DIRC detectors, the photon hit pattern is very complex. A novel reconstruction approach based on Kernel Density Estimation (KDE) was proposed and demonstrated in simulation to outperform the existing method based on look-up tables (LUT) [1]. I successfully adapted and applied this novel method to analyze the GlueX DIRC commissioning data. Some improvements were also made to better describe the data and improve the reconstruction performance. Although the data analysis is still in the preliminary stage, I demonstrated that this novel method has already achieved comparable performance with that obtained from the existing LUT method.
Alignment and Calibration

The precise knowledge of the geometry is critical in the successful operation of such type of DIRC detector due to its intricate optical system. To fully exploit the particle identification potential of GLUEX DIRC, we need to develop a data-driven strategy to carefully calibrate the detector. In the fellowship proposal, I proposed to investigate the possibility of applying the novel technique of Bayesian optimization (a global optimization strategy widely used in the machine learning community) to calibrate the GLUEX DIRC detector. I have successfully set up the optimization software pipeline and have run several calibration iterations. Active work is ongoing to better understand the commissioning data to allow better calibration. We are looking forward to the improvement of the DIRC performance from this novel calibration approach.

Travel and Presentation

During the fellowship period, I traveled to Jefferson Lab in January to participate in the installation and commissioning of the first half of the full DIRC and in June to install the PMTs for the other half of the DIRC system.

At the 2019 Jefferson Lab Users Organization meeting in June 24–26 2019, I gave a presentation on the status overview of the GLUEX DIRC project, which included some of the work I mentioned above.

References