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Development of the Data Acquisition System and the Analysis Status of the Λp Scattering Experiment at SPring-8

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Content

Hyperon-Nucleon (YN) interaction is one of the key elements in understanding the role of quarks in baryon-baryon interactions, including the nuclear force. Two-body scattering experiments are essential for deriving the two-body interaction, just as the current description of the NN interaction was obtained on the basis of the abundant scattering data. However, experimental data on YN scattering, particularly differential cross sections, have been highly limited due to experimental difficulties, such as a short lifetime of hyperon. As a result, our understanding of YN interactions is still incomplete. A well-known example is the so-called hyperon puzzle, a discrepancy between theoretical predictions and observational data of massive neutron stars.

To provide the high-statistics experimental data that can constrain theoretical models, we have been carrying on a Λp scattering experiment at SPring-8 since April 2025. Over the course of the 2.5-year experimental period, until July 2027, we aim to measure the differential cross section of Λp scattering using thousands of scattering events.

Λ particles produced via the $\gamma p \to K^+\Lambda$ are momentum-tagged using a magnetic spectrometer, where K^+ are clearly identified through the missing mass method. Scattering information is obtained by measuring the trajectories and energy deposits of recoil or decay particles with a cylindrical detector system. This system, called CATCH, consists of an 8-layer fiber tracker, BGO calorimeter, and plastic scintillators that cylindrically surround the liquid hydrogen target.

Development of the data acquisition (DAQ) system began in March 2024. We completely replaced the previous system and rebuilt it from scratch, including local networks, readout modules, and logic circuits.

To evaluate the full system, commissioning runs were carried out in November 2024 and January 2025. These runs confirmed that we can achieve over 95% DAQ efficiency at trigger rates up to 5 kHz.

The current trigger rate is below 2 kHz and DAQ efficiency is 95%, which is sufficient compared to the expected value in the experimental design, 90%.

This presentation provides an overview of the DAQ system, including its configuration, performance, and operational status. Additionally, we will report the current progress of the data analysis.

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