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BYACO: A Unified Platform for Analysis, Control, and Operation in Nuclear Physics Experiments

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Production of radioactive ion (RI) beams at RIKEN RIBF using the BigRIPS fragment separator requires dedicated studies of RI-beam separation and particle identification (PID), particularly for heavy-ions or low-energy beams. Challenges arise from the charge-state change and inaccurate energy loss predictions. While post-experiment analysis provides valuable insights for further improvements, real-time feedback based on complex analyses during experiments would substantially improve data quality by optimizing beamline and detector settings. To address these issues, we have developed BYACO (BeYond Analysis, Control, or Operation alone), a novel unified platform that integrates analysis tools, beamline and detector control systems, and data acquisition (DAQ) [1]. This platform enables advanced, real-time operation and optimization of RI-beam production and other experiments.

BYACO functions as a platform where each component shares real-time information and can be accessed via web APIs. A user-friendly front-end interface is provided through a web application. Furthermore, we have developed near-line analysis software and analysis programs that can execute offline-developed macros and connect to BYACO. These developments have allowed us to successfully implement sequences that execute complex analyses and modify settings based on the analysis results, such as a task of an automatic RI-beam tuning [2]. The energy-control tool of slowed-down RI beam was also developed. As experimental procedures become increasingly complex, and subsequently require more functionality, the agile development is crucial. Therefore, the server-side and front-end of BYACO are constructed by combining loosely coupled components. For future integration of machine learning and AI techniques, we plan to migrate to a microservice architecture, which is well-suited for the agile development using many loosely coupled components.

In this conference, we will introduce the development of BYACO and present examples of its applications and future perspectives.

[1] T. Sumikama et al., RIKEN Accel. Prog. Rep. 54, 82 (2021).

[2] Y. Shimizu et al., RIKEN Accel. Prog. Rep. 54, 83 (2021).

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