

Research Facility Development Division  
 Research Instruments Group  
 SAMURAI Team

## 1. Abstract

In collaboration with research groups in and outside RIKEN, the team designs, develops and constructs the SAMURAI spectrometer and relevant equipment that are and will be used for reaction experiments using RI beams at RI Beam Factory. The SAMURAI spectrometer consists of a large superconducting dipole magnet and a variety of detectors to measure charged particles and neutrons. After the commissioning experiment in March 2012, the team prepared and conducted, in collaboration with researchers in individual experimental groups, the first series of experiments with SAMURAI in May 2012. Then, amount numbers of experiments were well performed until now utilizing the property of SAMURAI. The team also provides a basis for research activities by, for example, organizing collaboration workshops by researchers who are interested in studies or plan to perform experiments with the SAMURAI spectrometer.

## 2. Major Research Subjects

Design, operation, maintenance and improvement of the SAMURAI spectrometer and its related research instruments. Support and management for SAMURAI-based research programs. Generate future plans for next generation instruments for nuclear reaction studies.

## 3. Summary of Research Activity

The current research subjects are summarized as follows:

- (1) Operation, maintenance and improvement of a large superconducting dipole magnet, the main component of the SAMURAI spectrometer
- (2) Design, development and construction of various detectors that are used for nuclear reaction experiments using the SAMURAI spectrometer
- (3) Preparation for planning experiments using SAMURAI spectrometer
- (4) Maintenance and improvement of the SAMURAI beam line
- (5) Formation of a collaboration platform called “SAMURAI collaboration”
- (6) Preparation for next generation spectrometer for nuclear reaction studies

## Members

### Team Leader

Hideaki OTSU

### Research & Development Scientist

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## List of Publications & Presentations

### Publications

#### [Original Papers]

- T. Phol *et al.*, “Multiple mechanisms in proton-induced nucleon removal at 100 MeV/nucleon,” *Phys. Rev. Lett.* **130**,172501 (2023).  
 A. Corsi *et al.*, “Searching for universality of dineutron correlation at the surface of Borromean nuclei,” *Phys. Lett. B* **840**, 137875 (2023).  
 S. Kim *et al.*, “Unbound states in  $^{17}\text{C}$  and  $p$ - $sd$  shell-model interactions,” *Phys. Lett. B* **836**, 137629 (2023).  
 A. I. Stefanescu *et al.*, “Silicon tracker array for RIB experiments at SAMURAI,” *Eur. Phys. J. A* **58**, 223 (2022).  
 M. Kaneko *et al.*, “Multiplicity trigger detector for the  $S\pi\text{RIT}$  experiment,” *Nucl. Instrum. Methods Phys. Res. A* **1039**, 167010 (2022).  
 M. Enciu *et al.*, “Extended  $p_{3/2}$  neutron orbital and the  $N = 32$  shell closure in  $^{52}\text{Ca}$ ,” *Phys. Rev. Lett.* **129**, 262501 (2022).  
 Z. Elekes *et al.*, “Southwestern boundary of the  $N = 40$  island of inversion: First study of low-lying bound excited states in  $^{59}\text{V}$  and  $^{61}\text{V}$ ,” *Phys. Rev. C* **106**, 064321 (2022).  
 J. W. Lee *et al.*, “Isoscaling in central Sn+Sn collisions at 270 MeV/nucleon,” *Eur. Phys. J. A* **58**, 201 (2022).  
 M. Duer *et al.*, “Observation of a correlated four-neutron system,” *Nature* **606**, 678–682 (2022).  
 M. Holl *et al.*, “Border of the island of inversion: Unbound states in  $^{29}\text{Ne}$ ,” *Phys. Rev. C* **105**, 034301 (2022).  
 T. Koiwai *et al.*, “A first glimpse at the shell structure beyond  $^{54}\text{Ca}$ : Spectroscopy of  $^{55}\text{K}$ ,  $^{55}\text{Ca}$ , and  $^{57}\text{Ca}$ ,” *Phys. Lett. B* **827**, 136953 (2022).

## Presentations

### [International Conferences/Workshops]

- SAMURAI International Collaboration Workshop 2022, Tokyo Institute of Technology, Tokyo & Online, September 2–3, 2022. <https://indico2.riken.jp/event/4219/>.
- T. Nakamura (invited), “Spectroscopy of nuclei near and beyond the neutron dripline,” ECT\* Workshop on “Nuclear Physics at the Edge of Stability,” Online & Trento, Italy (Hybrid), July 4–8, 2022.
- T. Nakamura (plenary/invited), “Summary Talk,” The 11th International Conference on Direct Reactions with Exotic Beams (DREB2022), Santiago de Compostela, Spain, June 26–July 1, 2022.
- Y. Kondo (invited), “Experimental studies near and beyond the dripline at SAMURAI,” Halo Week 2022, Bergen, Norway (Grand Hotel Terminus), July 10–15, 2022.
- Y. Kondo (invited), “Experimental studies of nuclei in the vicinity of the neutron-drip line at SAMURAI,” Physics of RI: Recent progress and perspectives, RIKEN, Saitama, Japan, May 30–June 1, 2022.

### [Domestic Conferences/Workshops]

- 久保田悠樹 (招待講演), 若手奨励賞講演, 「 $^{11}\text{Li}$  原子核中でのダイニュートロンの表面局在」, 日本物理学会春季大会, オンライン, 2023 年 3 月.
- 松井智輝, 「中性子過剰 He 同位体における多中性子系クラスターの探索」, 日本物理学会 2023 年春季大会, オンライン, 2023 年 3 月.
- H. Lee, “Coulomb Dissociation of  $^{17}\text{B}$ ,” 日本物理学会 2022 年秋季大会, 岡山市 (岡山理科大学), 2022 年 9 月.
- 磯部 駆, 「中性子過剰核における短距離相関対探索のための後方散乱粒子検出器の開発」, 日本物理学会秋季大会, 岡山市 (岡山理科大学), 2022 年 9 月.
- 松井智輝, 「多中性子クラスター探索実験に向けた反跳陽子検出器のテスト実験」, 日本物理学会秋季大会, 岡山市 (岡山理科大学), 2022 年 9 月.

## Press Release

- “Observation of a correlated free four-neutron system,” June 23, 2022, [https://www.riken.jp/press/2022/20220623\\_1/index.html](https://www.riken.jp/press/2022/20220623_1/index.html).

## Master Theses

- 堀川晃太, 「中性子過剰核における短距離相関探索実験」, 東京工業大学, 2023 年 2 月.
- 松井智輝, 「中性子過剰 He 同位体における多中性子クラスターの探索」, 東京工業大学, 2023 年 2 月.