

Nuclear Science Research Division
 Superheavy Element Research Group
 Superheavy Element Device Development Team

1. Abstract

A gas-filled recoil ion separator has been used as a main experimental device for the study of superheavy elements. This team is in charge of maintaining, improving, developing, and operating the separators and related devices. In the RIBF facility, three gas-filled recoil ion separators are installed at RILAC and RRC facility. One is GARIS that is designed for a symmetric reaction such as coldfusion reaction, and the other two are developed for an asymmetric reaction such as hot-fusion reaction, GARIS-II and GARIS-III. New elements 278113 were produced by $^{70}\text{Zn} + ^{209}\text{Bi}$ reaction using GARIS. Further the new element search is currently in progress by using GARIS-II and GARIS-III.

2. Major Research Subjects

- (1) Maintenance of GARIS, GARIS-II and development of new separator GARIS-III
- (2) Maintenance and development of detector and DAQ system for superheavy element research
- (3) Maintenance and development of target system for GARIS, GARIS-II and GARIS-III

3. Summary of Research Activity

The GARIS-II and III are newly developed which has an acceptance twice as large as existing GARIS, in order to realize higher transmission. A new element search program aiming to element 119 was started using GARIS-II. And new separator GARIS-III was developed and installed into the RILAC experimental hall. After the some commissioning works of GARIS-III, new 119th element search has been started. We will also offer user-support if a researcher wishes to use the devices for his/her own research program.

Members

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Student Trainees

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List of Publications & Presentations

Publications

[Original Papers]

- P. Brionnet, T. Cap, M. Forge, T. Fukatsu, H. Haba, D. Kaji, S. Kimura, K. Morimoto, Y. Michimoto, T. Niwase, M. Tanaka, S. Sakaguchi, H. Sakai, and Y. Yamanouchi, "Investigation of entrance-channel barrier distribution and charged-particle emission in the $^{51}\text{V} + ^{159}\text{Tb}$ reaction," *Phys. Rev. C* **110**, 064601 (2024).
- P. Brionnet, H. Haba, D. Kaji, S. Kimura, K. Morimoto, T. Niwase, S. Sakaguchi, and H. Sakai, Reaction parameter study of the ^{51}V beam onto deformed targets: $^{51}\text{V} + ^{159}\text{Tb}$ reaction, In *EPJ Web of Conferences* (Vol. 322, p. 02006), EDP Sciences, (2025).
- S. Kimura, M. Wada, H. Haba, H. Ishiyama, S. Ishizawa, Y. Ito, T. Niwase, M. Rosenbusch, P. Schury, and A. Takamine, "Comprehensive mass measurement study of ^{252}Cf fission fragments with MRTOF-MS and detailed study of masses of neutron-rich Ce isotopes," *Phys. Rev. C* **110**, 045810 (2024).

Presentations

[International Conferences/Workshops]

- P. Brionnet, "Reaction parameter study of the ^{51}V beam onto deformed targets: $^{51}\text{V} + ^{159}\text{Tb}$ reaction," CNR24* Conference, Vienna, Austria, July8–12, 2024.

- S. Sakaguchi for nSHE collaboration (invited), “Probing optimal energy for synthesis of element 119 from $^{51}\text{V} + ^{248}\text{Cm}$ reaction and fusion reaction studies for producing new elements and isotopes,” 14th International Conference on Nucleus-Nucleus Collisions (NN2024), Whistler, Canada, August 18–23, 2024.
- M. Takeyama (poster), T. Moriya, H. Saitoh, H. Miyahara, F. Miyake, H. Ozaki, T. Shiroishi, K. Morimoto, D. Kaji, K. Nakamura, S. Itoh, K. Kosugi, and F. Tokanai, “Readout system of pixelated silicon detector for compact AMS,” 16th International Conference on Accelerator Mass Spectrometry (AMS-16), Guilin, China, October 20–26, 2024.
- M. Takeyama (poster), F. Tokanai, K. Kuramoto, K. Morimoto, D. Kaji, P. Brionnet, and K. Kosugi, “Silicon pad detector with large effective area for SHE experiments,” Vienna Conference on Instrumentation 2025 (VCI 2025), Vienna, Austria, February 17–21, 2025.

[Domestic Conferences/Workshops]

- P. Brionnet, “Identification of fast-decaying non-fusion reaction products in the search of new element $Z = 119$ at RIKEN,” 76th Annual Meeting JPS, Hokkaido University, September 16–19, 2024.
- P. Brionnet, “Identification of fast-decaying background isotopes during the search of the new element $Z = 119$ at RIKEN,” RIBF User Meeting 2025, RIKEN, Japan, Jan 21, 2025.
- 門叶冬樹 (口頭発表), 森本幸司, 加治大哉, Brionnet Pierre, 武山美麗, 倉本幸作, 加藤紘大, 小杉和正, 間嶋拓也, 安田啓介, 「超重元素実験用シリコン半導体検出器の開発」, 第 85 回応用物理学会秋季学術講演会, 新潟市 (朱鷺メッセ), 2024 年 9 月 16–20 日.
- 坂口聡志 (招待講演), 「超重元素合成のための重イオン核融合反応の研究」, 研究会「核反応の時間発展ダイナミクスの解明に向けて」, 和光市 (理化学研究所), 2024 年 9 月 26–27 日.
- 庭瀬曉隆 (招待講演), 「r 過程終焉部の解明へ向けたアクチノイド核の精密質量測定」, 宇宙史センター構成員会議, 2024 年 7 月 2 日.
- 庭瀬曉隆, 和田道治, Peter Schury, 木村創大, Pierre Brionnet, Chaoyi Fu, 羽場宏光, 平山賀一, 石山博恒, 伊藤由太, 加治大哉, 宮武宇也, 森本幸司, Marco RosenbuschB, 高峰愛子, 渡邊裕, 「MRTOF 質量分光器を用いたイオン計数による蒸発残留核の励起関数測定」, 日本物理学会第 79 回年次大会, 札幌市 (北海道大学), 2024 年 9 月 16–19 日.
- T. Niwase (invited), “Silicon detectors for superheavy element researches and solar cell detectors,” KEK 測定器開発センター・プラットフォーム B (シリコン検出器) 第 9 回研究会, 2025 年 1 月 9–10 日.
- Y. Yamanouchi (poster), S. Sakaguchi, T. Niwase, and Y. Michimoto, nSHE collaboration, “Excitation function measurement of the $^{51}\text{V} + ^{159}\text{Tb}$ fusion reaction for estimating the optimal reaction energy for producing new element 119,” SNP-CNS Summer School 2024, Wako, Japan, August 3–8, 2024.
- 山ノ内邑希 (口頭発表), 坂口聡志, 庭瀬曉隆, nSHE collaboration, 「119 番元素合成のための最適反応エネルギー推定に向けた $^{51}\text{V} + ^{159}\text{Tb}$ 融合反応の励起関数測定」, 日本物理学会第 79 回年次大会, 札幌市 (北海道大学), 2024 年 9 月 16–19 日.
- 山ノ内邑希 (口頭発表), 坂口聡志, 庭瀬曉隆, nSHE Collaboration, 「新元素合成のための最適反応エネルギー推定に向けた $^{51}\text{V} + ^{159}\text{Tb}$ 融合反応の励起関数測定」, 日本放射化学会第 68 回討論会, 静岡市 (グランシップ), 2024 年 9 月 23–25 日.
- 山ノ内邑希 (口頭発表), 坂口聡志, 庭瀬曉隆, Pierre Brionnet, for nSHE collaboration, 「新元素合成の最適反応エネルギー推定精度向上に向けた $^{51}\text{V} + ^{159}\text{Tb}$ 融合反応の励起関数測定」, 第 130 回日本物理学会九州支部例会, 福岡市 (福岡工業大学), 2024 年 11 月 16 日.
- 山ノ内邑希 (口頭発表), Pierre Brionnet, 坂口聡志, Tomasz Cap, Margaux Forge, 深津巧光, 羽場宏光, 加治大哉, 木村創大, 森本幸司, 道本優也, 庭瀬曉隆, 酒井英行, 田中聖臣, 「新元素合成のための最適入射エネルギー推定に向けた $^{51}\text{V} + ^{159}\text{Tb}$ 反応の研究」, 日本物理学会 2025 年春季大会, オンライン, 2025 年 3 月 18–21 日.
- 山ノ内邑希 (ポスター発表), Pierre Brionnet, 坂口聡志, Tomasz Cap, Margaux Forge, 深津巧光, 羽場宏光, 加治大哉, 木村創大, 森本幸司, 道本優也, 庭瀬曉隆, 酒井英行, 田中聖臣, 「新元素合成における最適入射エネルギー推定に向けた $^{51}\text{V} + ^{159}\text{Tb}$ 準弾性散乱障壁分布と融合反応の励起関数測定」, 第 13 回停止・低速 RI ビームを用いた核分光研究会, 福岡市 (九州大学), 2025 年 2 月 20–21 日.
- 道本優也 (口頭発表), 坂口聡志, 庭瀬曉隆, nSHE collaboration, 「119 番元素合成のための最適反応エネルギー推定に向けた $^{51}\text{V} + ^{159}\text{Tb}$ 融合反応の障壁分布測定」, 日本物理学会第 79 回年次大会, 札幌市 (北海道大学), 2024 年 9 月 16–19 日.
- 道本優也 (口頭発表), 坂口聡志, 庭瀬曉隆, Pierre Brionnet, nSHE collaboration, 「新元素合成の最適反応エネルギー推定精度向上に向けた $^{51}\text{V} + ^{159}\text{Tb}$ 融合反応の障壁分布測定」, 第 130 回日本物理学会九州支部例会, 福岡市 (福岡工業大学), 2024 年 11 月 16 日.

Outreach Activities

- 森本幸司, 科学者に聞いてみよう「ニホニウムってなんだ!？」～誕生 20 周年記念講演会～, 理化学研究所, 2024 年 11 月 3 日.