

Research Facility Development Division
Accelerator Group
Beam Dynamics & Diagnostics Team

1. Abstract

Aiming at stable and efficient operation of the RIBF cascaded cyclotron system, Beam Dynamics and Diagnostics Team develops power supplies, beam instrumentation, computer control and beam dynamic studies. We have successfully increased the beam availability for user experiments to more than 98%. We have also established small-beam-loss operations. The latter strongly contributes to recent high-power operations at RIBF.

2. Major Research Subjects

- (1) More efficient and stable operations of the RIBF cascaded cyclotron system
- (2) Maintenance and developments of the beam instrumentation
- (3) Developments of computer control system for more intelligent and efficient operations
- (4) Maintenance and improvements of the magnet power supplies for more stable operations
- (5) Upgrade of the existing beam interlock system for high-power beams with few tens of kW

3. Summary of Research Activity

- (1) High-intensity heavy-ion beams such as 117-particle-nA (pnA) uranium, 173-pnA xenon, 486-pnA krypton, 788-pnA Zinc and 740-pnA calcium beams have been obtained.
- (2) The world-first high-Tc SQUID beam current monitor has been developed.
- (3) The bending power of the fixed-frequency Ring Cyclotron has been upgraded to 700 MeV.
- (4) The world-most-intense V beams are stably supplied to super-heavy-element-search experiments.
- (5) The RIBF control system has been operated stably by replacing legacy hardware controllers carried over from our old facility with new ones. Several useful operation tools are also developed.
- (6) The dated power supplies exciting the main coils of RIKEN Ring Cyclotron has been upgraded to a new one having a better long-term stability than the old ones.
- (7) Developments of automatic beam tuning methods based on recent machine-learning technology and adaptive control are in progress.

Members

Team Leader

Nobuhisa FUKUNISHI

Senior Technical Scientists

Masaki FUJIMAKI
Keiko KUMAGAI
Akito UCHIYAMA

Tamaki WATANABE
Kazunari YAMADA

Expert Technician

Misaki KOMIYAMA

Postdoctoral Researcher

Takahiro NISHI

Research Associate

Hiroki FUJII

Visiting Scientists

Shin-ichiro HAYASHI (Hiroshima Int'l Univ.)
Atsushi KAMOSHIDA (Nat'l Instruments Japan Corporation)

Takuya MAEYAMA (Kitasato Univ.)

List of Publications & Presentations

Publication

[Review Article]

K. Yamada, K. Ozeki, and K. Suda, "Helium cryogenic system for the RIKEN superconducting heavy-ion linear accelerator—System overview and operation," *Teion Kogaku (J. Cryo. Super. Soc. Jpn.)* **56**, 201–208 (2021).

[Proceedings]

- A. Uchiyama, M. Komiyama, M. Kidera, and N. Fukunishi, “Data archive system for superconducting RIKEN linear accelerator at RIBF,” 12th International Particle Accelerator Conference (IPAC’21), Campinas, Brazil (virtual format), 2178–2181 (2021).
- K. Yamada, T. Dantsuka, M. Fujimaki, E. Ikezawa, H. Imao, O. Kamigaito, M. Komiyama, K. Kumagai, T. Nagatomo, T. Nishi, H. Okuno, K. Ozeki, N. Sakamoto, K. Suda, A. Uchiyama, T. Watanabe, Y. Watanabe, H. Hara, A. Miyamoto, K. Sennyu, T. Yanagisawa, E. Kako, H. Nakai, H. Sakai, and K. Umemori, “Successful beam commissioning of heavy-ion superconducting linac at RIKEN,” Proceedings of 20th International Conference on RF Superconductivity (SRF2021), 167–174 (2021).
- A. Uchiyama, M. Komiyama, M. Fujimaki, K. Kumagai, H. Yamaychi, and K. Kaneko, “Development of machine protection system for SRILAC,” Proceedings of the 18th Particle Accelerator Society of Japan, TUP042, 532–535 (2021).
- T. Watanabe, A. Kamoshida, A. Uchiyama, T. Nishi, R. Koyama, and K. Kaneko, “Distributed control by EPICS for the SRILAC beam energy position monitoring system using LabVIEW,” Proceedings of the 18th Particle Accelerator Society of Japan, WEP026, 683–686 (2021).
- A. Uchiyama, M. Fujimaki, N. Fukunishi, Y. Higurashi, E. Ikezawa, H. Imao, O. Kamigaito, M. Kidera, M. Komiyama, K. Kumagai, T. Nagatomo, T. Nakagawa, T. Nishi, J. Ohnishi, K. Ozeki, N. Sakamoto, K. Suda, T. Watanabe, Y. Watanabe, K. Yamada, A. Kamoshida, K. Kaneko, R. Koyama, T. Ohki, K. Oyamada, M. Tamura, H. Yamauchi, and A. Yusa, “Control system of the SRILAC project at RIBF,” 18th International Conference on Accelerator and Large Experimental Physics Control Systems (ICALEPCS2021), Shanghai, China (virtual format), 147–152 (2021).
- M. Komiyama, A. Uchiyama, M. Fujimaki, K. Kumagai, N. Fukunishi, T. Nakamura, and M. Hamanaka, “Performance verification of new machine protection system prototype for RIKEN RI Beam Factory,” 18th International Conference on Accelerator and Large Experimental Physics Control Systems (ICALEPCS2021), Shanghai, China (virtual format), 742–745 (2021).

Presentations**[International Conferences/Workshops]**

- N. Fukunishi (poster), A. Uchiyama, M. Komiyama, and M. Kidera, “Data archive system for superconducting RIKEN linear accelerator at RIBF,” 12th International Particle Accelerator Conference (IPAC’21), Campinas, Brazil (virtual format), May 24–28, 2021.
- K. Yamada (invited), T. Dantsuka, M. Fujimaki, E. Ikezawa, H. Imao, O. Kamigaito, M. Komiyama, K. Kumagai, T. Nagatomo, T. Nishi, H. Okuno, K. Ozeki, N. Sakamoto, K. Suda, A. Uchiyama, T. Watanabe, Y. Watanabe, H. Hara, A. Miyamoto, K. Sennyu, T. Yanagisawa, E. Kako, H. Nakai, H. Sakai, and K. Umemori, “Successful beam commissioning of heavy-ion superconducting linac at RIKEN,” 20th International Conference on RF Superconductivity (SRF2021), MOOFAV01, East Lansing, USA, Online, June 28–July 2, 2021.
- M. Hamanaka (poster), M. Komiyama, A. Uchiyama, M. Fujimaki, K. Kumagai, N. Fukunishi, and T. Nakamura, “Performance verification of new machine protection system prototype for RIKEN RI Beam Factory,” 18th International Conference on Accelerator and Large Experimental Physics Control Systems (ICALEPCS2021), Shanghai, China (virtual format), October 14–22, 2021.
- A. Yusa (poster), A. Uchiyama, M. Fujimaki, N. Fukunishi, Y. Higurashi, E. Ikezawa, H. Imao, O. Kamigaito, M. Kidera, M. Komiyama, K. Kumagai, T. Nagatomo, T. Nakagawa, T. Nishi, J. Ohnishi, K. Ozeki, N. Sakamoto, K. Suda, T. Watanabe, Y. Watanabe, K. Yamada, A. Kamoshida, K. Kaneko, R. Koyama, T. Ohki, K. Oyamada, M. Tamura, and H. Yamauchi, “Control system of the SRILAC project at RIBF,” 18th International Conference on Accelerator and Large Experimental Physics Control Systems (ICALEPCS2021), Shanghai, China (virtual format), October 14–22, 2021.
- M. Hamanaka (poster), M. Komiyama, A. Uchiyama, M. Fujimaki, K. Kumagai, N. Fukunishi, and T. Nakamura, “Performance verification of new machine protection system prototype for RIKEN RI Beam Factory,” 18th International Conference on Accelerator and Large Experimental Physics Control Systems (ICALEPCS2021), Shanghai, China (virtual format), October 14–22, 2021.

[Domestic Conferences/Workshops]

- 金子健太 (ポスター発表), 内山暁仁, 込山美咲, 藤巻正樹, 熊谷桂子, 山内啓資, 「SRILAC 用マシンプロテクションシステムの構築」, 日本物理学会第 18 回年次大会, QST 高崎-オンライン, 2021 年 8 月 9–12 日.
- 金子健太 (ポスター発表), 渡邊環, 鴨志田敦史, 内山暁仁, 福西暢尚, 西隆博, 小山亮, 「LabVIEW を用いた SRILAC ビームエネルギー・位置モニターシステムの EPICS による分散制御」, 第 18 回日本加速器学会年会, QST 高崎-オンライン, 2021 年 8 月 9–12 日.
- 仲村武志 (ポスター発表), 込山美咲, 他 37 名, 「理研 RIBF におけるリングサイクロトロン運転報告」, 日本物理学会第 18 回年次大会, QST 高崎-オンライン, 2021 年 8 月 9–12 日.
- 福澤聖児 (ポスター発表), 込山美咲, 他 35 名, 「理研 AVF サイクロトロン運転の現状報告」, 日本物理学会第 18 回年次大会, QST 高崎-オンライン, 2021 年 8 月 9–12 日.
- 渡邊環 (招待講演), 「理研超伝導加速空洞用ビームエネルギー・位置モニター」, 第 7 回 IFMIF 研究会 ~ビーム診断・ビーム制御~, 量子科学技術研究開発機構六ヶ所研 (北郡六ヶ所村), オンライン, 2022 年 3 月 7 日.

Patents

- T. Watanabe and N. Fukunishi, “Charged particle beam current measurement apparatus (日本語: 荷電粒子ビームの電流測定装置),” 2021, 6843903, JY Patent.
- T. Watanabe and N. Fukunishi, “Charged particle beam current measurement apparatus,” 2021, 17836891.6, FR, DE Patent.