

Research Facility Development Division
Accelerator Group
RILAC Team

1. Abstract

Our team is responsible for the operation, maintenance, and upgrade of the RIKEN heavy-ion linear accelerator (RILAC), a unique variable-frequency linac that has been in operation since 1980. RILAC was upgraded in the 1990s as part of the RI Beam Factory (RIBF) project, and made a significant contribution to the synthesis and discovery of the element 113, nihonium. In 2019, a superconducting linac booster, SRILAC, was installed, and it will play a major role in the synthesis of heavier new elements, development of the technologies for production of medical radioisotopes, and as a powerful injector to RIBF.

2. Major Research Subjects

- (1) Development of technology to operate RILAC with high intensity and high stability
- (2) Construction and maintenance of the RILAC beamlines
- (3) Efficient operation, maintenance and management of the vacuum equipment in the RIBF accelerators

3. Summary of Research Activity

In 2021, we have made various improvements of the whole RILAC with the cooperation of other teams of the Accelerator Group, in order to provide high-intensity beams more stably to the new element synthesis experiments being conducted at GARIS III. For example, leak of refrigerant in the normal conducting cavities was thoroughly investigated and repaired. In addition, vacuum leak at the couplers of the superconducting cavities, which had been a problem since its start, was repaired. With these efforts, the beam availability has been improved significantly.

A beamline is being prepared at the RILAC facility for mass production of ^{211}At , which has potential medical applications. Under the leadership of the RI Application Research Group and with the help of other teams of the Accelerator Group, the optical calculations, electromagnet design, radiation shielding design, and overall beamline installation were undertaken and the beamline is almost complete.

As in the past, we maintained the vacuum system of the whole accelerators at RIBF. While taking into consideration the aging of the vacuum pumps, an efficient maintenance plan was established and cost-conscious maintenance was executed.

Members

Team Leader

Osamu KAMIGAITO

Deputy Team Leader

Naruhiko SAKAMOTO

Research/Technical Scientists

Yutaka WATANABE (Senior Technical Scientist)

Takahiro NISHI (Research Scientist)

Research Consultant

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List of Publications & Presentations

[Proceedings]

- T. Nishi, E. Iwai, A. Uchiyama, Y. Shimizu, T. Sugimoto, H. Suzuki, H. Takeda, N. Fukuda, N. Fukunishi, H. Fujii, H. Maesaka, and M. Yoshimoto, "Development of auto tuning system of ion optics for high intensity primary beam using machine learning," Proceedings of the 18th Annual Meeting of Particle Accelerator Society of Japan, QST-Takasaki Online, Japan, August 9–12, 2021, TUOA03, 71–74 (2021). https://www.pasj.jp/web_publish/pasj2021/proceedings/PDF/TUOA/TUOA03.pdf.
- T. Nakamura, K. Ozeki, S. Fukuzawa, M. Hamanaka, S. Ishikawa, K. Kobayashi, R. Koyama, M. Nishida, M. Nishimura, J. Shibata, N. Tsukiori, K. Yadomi, T. Dantsuka, M. Fujimaki, T. Fujinawa, N. Fukunishi, H. Hasebe, Y. Higurashi, E. Ikezawa, H. Imao, O. Kamigaito, Y. Kanai, M. Kidera, M. Komiyama, K. Kumagai, T. Maie, T. Nagatomo, T. Nakagawa, M. Nakamura, J. Ohnishi, H. Okuno, N. Sakamoto, S. Kenji, A. Uchiyama, W. Shu, W. Tamaki, Y. Watanabe, K. Yamada, and H. Yamasawa, "Status report on the operation of RIKEN AVF cyclotron," Proceedings of the 18th Annual Meeting of Particle Accelerator Society of Japan, QST-Takasaki Online, Japan, August 9–12, 2021, TUP052, 575–579 (2021). https://www.pasj.jp/web_publish/pasj2021/proceedings/PDF/TUP0/TUP052.pdf.
- S. Fukuzawa, K. Suda, A. Goto, J. Ohnishi, M. Hamanaka, S. Ishikawa, K. Kobayashi, R. Koyama, T. Nakamura, M. Nishida, M. Nishimura, J. Shibata, N. Tsukiori, K. Yadomi, M. Fujimaki, N. Fukunishi, H. Hasebe, Y. Higurashi, H. Imao, O. Kamigaito, M. Kase, M. Kidera, M. Komiyama, K. Kumagai, T. Maie, T. Nagatomo, T. Nakagawa, H. Okuno, K. Ozeki, N. Sakamoto,

- A. Uchiyama, S. Watanabe, T. Watanabe, Y. Watanabe, K. Yamada, K. Kamakura, and Y. Kotaka, “Status report on the operation of RIKEN AVF cyclotron,” Proceedings of the 18th Annual Meeting of Particle Accelerator Society of Japan, QST-Takasaki Online, Japan, August 9–12, 2021, WEP052, 760–764 (2021). https://www.pasj.jp/web_publish/pasj2021/proceedings/PDF/WEP0/WEP052.pdf.
- T. Ohki, H. Yamauchi, K. Oyamada M. Tamura, A. Yusa, K. Kaneko, N. Sakamoto, M. Fujimaki, E. Ikezawa, H. Imao, M. Kidera, T. Nagatomo, T. Nishi, K. Ozeki, K. Suda, A. Uchiyama, T. Watanabe, Y. Watanabe, K. Yamada, and O. Kamigaito, “Present status of RILAC,” Proceedings of the 18th Annual Meeting of Particle Accelerator Society of Japan, QST-Takasaki Online, Japan, August 9–12, 2021, THP059, 983–985 (2021). https://www.pasj.jp/web_publish/pasj2021/proceedings/PDF/THP0/THP059.pdf.

Presentations

[International Conferences/Workshops]

- T. Yanagisawa (invited), 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, E. Kako, H. Nakai, H. Sakai, K. Umemori, H. Hara, A. Miyamoto, and K. Sennyu, “Successful beam commissioning of heavy-ion superconducting linac at RIKEN,” 2021 International Conference on RF Superconductivity (SRF2021), East Lansing, MI, USA, Online, June 28–July 2, 2021.
- K. Yamada (invited), T. Nishi, M. Fujimaki, N. Fukunishi, H. Imao, O. Kamigaito, T. Nagatomo, N. Sakamoto, A. Uchiyama, T. Watanabe, and Y. Watanabe, “Beam acceleration with the upgraded RIKEN heavy-ion linac,” 64th ICFA Advanced Beam Dynamics Workshop on High-Intensity and High-Brightness Hadron Beams (HB2021), Batavia, IL, USA, Online, October 4–8, 2021.
- A. Yusa (poster), A. Uchiyama, M. Fujimaki, N. Fukunishi, Y. Higurashi, E. Ikezawa, H. Imao, O. Kamigaito, M. Kidera, K. Kumagai, T. Nagatomo, T. Nishi, J. Ohnishi, K. Ozeki, N. Sakamoto, K. Suda, T. Watanabe, Y. Watanabe, K. Yamada, M. Komiyama, 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 (ICALEPCS 2021), China, Shanghai, October 14–22, 2021.

[Domestic Conferences/Workshops]

- 西隆博 (招待講演), 「理化学研究所におけるガウシアンプロセスを用いた一次重イオンビームトランスポートの自動調整の開発」, 日本物理学会 第 77 回年次大会, オンライン, 2022 年 3 月 15 日–19 日.
- 吉本雅浩 (口頭発表), 西隆博, 岩井瑛人, 内山暁仁, 清水陽平, 杉本崇, 鈴木宏, 竹田浩之, 福田直樹, 藤井洋樹, 前坂比呂和, 「機械学習を用いた高強度一次ビームのイオン光学系の自動調整の開発」, 第 18 回日本加速器学会年会, オンライン, 2021 年 8 月 9–12 日.
- 上垣外修一 (ポスター発表), 大木智則, 小山田和幸, 山内啓資, 田村匡史, 遊佐陽, 金子健太, 坂本成彦, 藤巻正樹, 池沢英二, 今尾浩士, 木寺正憲, 長友傑, 大関和貴, 須田健嗣, 内山暁仁, 渡邊環, 渡邊裕, 山田一成, 「理研重イオンリニアックの現状報告」, 第 18 回日本加速器学会年会, オンライン, 2021 年 8 月 9–12 日.
- 小高康熙 (ポスター発表), 福澤聖児, 須田健嗣, 後藤彰, 大西純一, 濱仲誠, 石川盛, 小林清志, 小山亮, 仲村武志, 西田稔, 柴田順翔, 月居憲俊, 矢富一慎, 藤巻正樹, 福西暢尚, 長谷部裕雄, 日暮祥英, 今尾浩士, 上垣外修一, 加瀬昌之, 木寺正憲, 込山美咲, 熊谷桂子, 眞家武士, 長友傑, 中川孝秀, 奥野広樹, 大関和貴, 坂本成彦, 内山暁仁, 渡部秀, 渡邊環, 渡邊裕, 山田一成, 鎌倉恵太, 「理研 AVF サイクロロン運転の現状報告」, 第 18 回日本加速器学会年会, オンライン, 2021 年 8 月 9–12 日.
- 山澤秀行 (ポスター発表), 仲村武志, 福澤聖児, 濱仲誠, 石川盛, 小林清志, 小山亮, 西田稔, 西村誠, 柴田順翔, 月居憲俊, 矢富一慎, 大関和貴, 段塚知志, 藤巻正樹, 藤縄雅, 福西暢尚, 長谷部裕雄, 日暮祥英, 池沢英二, 今尾浩士, 上垣外修一, 金井保之, 加瀬昌之, 木寺正憲, 込山美咲, 熊谷桂子, 眞家武士, 長友傑, 中川孝秀, 中村仁音, 大西純一, 奥野広樹, 坂本成彦, 須田健嗣, 内山暁仁, 渡部秀, 渡邊環, 渡邊裕, 山田一成, 「理研 RIBF におけるリングサイクロロンの運転報告」, 第 18 回日本加速器学会年会, オンライン, 2021 年 8 月 9–12 日.

Outreach Activity

- 熊谷洗希, 渋谷遥斗, 森内厚佑, 水谷凜都, 登藤成琉, 丸田京華, 秋山翔希, 西隆博, 田中香津生, 遠藤金吾, 「秋田県における地上での μ 粒子検出頻度と天気ごとの地上気温、湿度、気圧との偏相関」, J. Sci. EGGs, **4**, 2110004, 1–6 (2021). https://www3.e-kenkyu.com/j-sci-eggs/uploads/manuscript/file/21/Vol.4-2110004_2021.pdf.