

## PREFACE

The RIKEN Accelerator Progress Report is the annual report of all the research activities conducted at the RIKEN Nishina Center for Accelerator-Based Science (RNC). This volume (No. 56) covers the activities conducted during the Japanese fiscal year 2022 (i.e., April 2022 to March 2023).

With restrictions on social activity due to the coronavirus pandemic being gradually eased last year, we have been able to reconnect with friends and families in person for the first time since the spring of 2020. The same was true research-wise, with many researchers from abroad visiting to RIKEN to participate in the experiments scheduled at the end of the year. At the end of October 2022, “The

Yoshio Nishina Memorial Event” was successfully held in person as well. With the attendance of guests related to or have connection with Dr. Nishina who came all the way to Wako, the event turned out to be a great opportunity to spark interest not just among the participants but to a wider community about Dr. Nishina’s achievements and the Nishina Center’s latest initiatives and research activities.

One of the messages that we wanted to communicate through “The Nishina Yoshio Memorial Laboratory” is the “Copenhagen Spirit” that took hold in the research field pioneered by Dr. Nishina. The Spirit is still very much alive in Japan, and I think the main reason is because it matches the philosophy of “Yaoyorozu no kami (eight million gods),” a traditional Japanese belief that says god exists in everything. Because individual’s ideas and curiosity are the base of science and technology, each one can be called a Creator. Every social activity should acknowledge and embrace differences in one’s sensibility and heighten each other’s originality. It is my wish that we will contribute to realizing a peaceful society where individuals can shine, an endeavor to be achieved when the essence and role of science and technology are fully incorporated into society while not repeating the mistakes made about 80 years ago.

95 years later, since the first cyclotron built by Dr. Yoshio Nishina, the superconducting ring cyclotron (SRC) was registered in the Guinness World Records in April 2022, as the highest energy beam cyclotron which achieves 82,400 MeV of a uranium beam. The SRC was constructed with advanced technology from Japanese industries and completed in 2006. Since then, the uranium beam has been utilized in more than 100 publications. The other beams also have made a significant contribution to the development of the low energy nuclear physics.

Yasuki Akiba has been appointed as the Director of RHIC Physics Research Group to conduct the sPHENIX program at RHIC as of April 2022. Tetsuya Ohnishi has succeeded, as the Director of Instrumentation Development Group as of October 2022. Yoshihide Higurashi has been appointed as the Team Leader of RILAC Team as of October 2022.

In March 2023, an event celebrating three decades of collaboration between RAL and RIKEN was organized. The RIKEN-RAL Muon Facility was concluded at the end of March. The muon programs have produced over 500 publications, including muon-catalyzed fusion, condensed matter physics and chemistry and battery materials, and have made new departures in international collaborations, involving South-East Asian countries such as Indonesia, Malaysia, and Thailand. A new partnership between ISIS RNC has been established since April 2023 to encourage collaboration in areas of accelerator-based sciences.

Many outstanding research results were obtained at RNC last year. Twelve press releases were disseminated in FY2022. Selected strides made in 2022 have been compiled in the “Highlights of the Year” section in this volume, which show successful multi-disciplinary activities of RNC for science, technology, and innovation. One of the highlights was the successful observation of four neutron states by using a different method to observe the phenomenon already observed few years ago. This research achievement has been chosen by the Institute of Physics as one of the “Top 10 Breakthroughs of the Year for 2022.” The discovery of  $^{39}\text{Na}$  was featured by the YouTube program of “Periodic Table of Videos.” The first mass measurement with Rare-RI Ring was published to give an impact to the  $r$ -

