ImPACT-OEDO workshop

H. Otsu,[*1] N. Imai,[*2] S. Michimasa,[*2] T. Sumikama,[*1] D. Suzuki,[*1] K. Washiyama,[*3] Y. Watanabe,[*4] and Y. X. Watanabe[*5]

The ImPACT-OEDO workshop[1] was held on July 13 and 14, 2017 at the RIKEN Wako campus. The workshop was jointly organized by the RIKEN Nishina Center and the Center for Nuclear Study, the University of Tokyo. A total of 70 participants with physics or engineering backgrounds gathered from institutions throughout Japan.

The project "Reduction and Resource Recycling of High-level Radioactive Wastes through Nuclear Transmutation" is one of the selected programs of the ImPACT (Impulsing Paradigm Change through Disruptive Technologies) program under the initiative of the Cabinet Office. The project has been in operation since 2014 under the collaboration of a number of major research institutes in Japan, including the RIKEN Nshina Center. Its mission is to develop a new method to transmutate long-lived fission products (LLFP) that would otherwise remain highly toxic and to pave a realistic path toward a sustainable society. At the RIBF and other facilities, the collaboration has been conducting a number of measurements of reaction rates of nuclei identified as LLFPs. In parallel, theoretical studies have been widely and actively carried out to interpret the experimental results and extract nuclear data that can be incorporated into state-of-the-art simulation codes. In addition, FY2017 is marked by the inauguration of the OEDO beam line at the RIBF. This new beam line is capable of decelerating fast radioactive isotope beams of the RIBF down to energies below 50 MeV/nucleon. With the OEDO beam line, the RIBF will enable reaction measurements of LLFPs over a wide range of energies.

The ImPACT-OEDO workshop was organized to overview and discuss a wide range of activities related to nuclear data of LLFPs that have been carried out in the ImPACT project. Another important goal is to stimulate discussions on future experiments that will be conducted at the OEDO beam line.

The two-day workshop started with an overview of the ImPACT program by H. Sakurai (Nishina Center), which was followed by another overview of the subworking group for nuclear data by S. Shimoura (Center for Nuclear Study). A total of 29 speakers orally presented their activities and future plans in six sessions. Four sessions were dedicated to recent or on-going studies, and the remaining two were focused on future experiments at the OEDO beam line.

The experiments reported include a series of reaction studies of LLFPs at the RIBF using a beam of LLFPs produced from the fission of a ^{238}U beam. The reaction products from spallation or Coulomb breakup reactions of ^{107}Pd or ^{93}Zr were measured in flight. The deduced cross sections to transmuate LLFPs into stable nuclei or the inclusive total reaction cross sections were presented. Another transmutation method under study uses muon capture. Recent measurements of muon capture rates and decay branches in the RCNP or in the RIKEN-RAL facility were presented. These newly aquired data were discussed in several reports on theoretical studies. One major topic is related to the integration of the measured data into widely-used nuclear reaction simulation codes such as PHITS.[2] It was discussed how the nuclear data should be extracted from the measured data and be inputted into the code, in addition to how the results will improve the applicability of the simulation to LLFPs. Another direction in theoretical activities is to further our understanding of nuclear reactions within the framework of modern nuclear theory, such as the effective-mean-field and direct-reaction formalisms, so that more reliable predictions of nuclear data can be made. In addition to these experimental and theoretical studies, a few engineering activities were reported. The talks on the development of a new isotope separation method to chemically isolate LLFPs and on a new superconducting cavity as a key device for realizing intense beam acceleration highlighted the interdisciplinary nature of this project.

The completion of the OEDO beam line was appreciated by the audience. The development history and successful in-beam commissioning were presented. The plan of the first physics experiments was discussed. One envisioned experiment is to extract neutron capture cross sections of the LLFP ^{79}Se from (d, p) reaction cross sections using the so-called surrogate method. The reaction mechanism behind this method was also discussed. The other is to measure excitation functions of proton- and deuteron-induced reactions of ^{107}Pd. The participants also had animated discussions on future experiments using energy-degraded RI beams that will be provided by the OEDO beam line.

Works discussed in the workshop were supported by the ImPACT program of the Council for Science, Technology and Innovation (Cabinet Office, Gouvernment of Japan).

*1 RIKEN Nishina Center
*2 Center for Nuclear Study, University of Tokyo
*3 Department of Physics, Tsukuba University
*4 Department of Advanced Energy Enginnering Science, Kyushu University
*5 Wako Nuclear Science Center, KEK

References

1) Workshop website: https://indico2.riken.jp/event/2534
2) K. Niita *et al.*, Radiat. Meas. **41**, 1080 (2006).

Nishina School 2017

T. Motobayashi*1 and H. Ueno*2

The 11th Nishina School was held from July 24 to August 4, 2017. The school aims at guiding Asian undergraduate students who are deciding their future field of study. A photograph taken at the beginning of the school is shown in Fig. 1. Students and supervisors from Peking University (PKU) and the University of Hong Kong (HKU) joined this 11th School. High-school students from Phillips Exeter Academy, USA, along with their teachers, participated in most of the School programs.

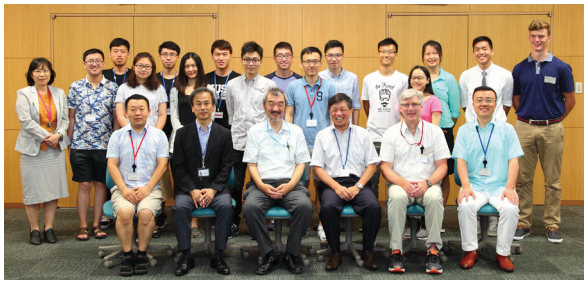

Fig. 1. Photograph of Nishina School 2017 participants.

The 11th School began with self-introductions by the students of PKU and HKU, followed by welcome addresses by Hideto En'yo, Nishina Center Director and Shunichiro Itakura, RIKEN's Executive Director. The first week is dedicated mostly to lectures and training on a few subjects related to the nuclear reaction experiment performed in the second week of the school.

The lectures were on a few basic topics for research, including overviews of nuclear physics and nuclear astrophysics, the function of particle accelerators, and methods of radiation measurements. Other lectures were devoted to radiation safety, paper writing and oral presentation, and issues that researchers may encounter in their future. The subjects of training were electronic-pulse propagation and radiation detection. The detectors, electronics, and data acquisition systems to be used in the experiment in the following week were employed in the training.

The second-week program was focused on the reaction experiment using proton beams from the Pelletron accelerator at RIKEN Nishina Center. The students were divided into four teams, which were in charge of four different types of measurements. They designed the experiment by first evaluating the feasibility of measurements, then set the detectors around the reaction target, and determined the conditions of beam exposure based on their considerations. After the experiment, they analyzed the experimental data obtained, and finally made presentations on their results. The reaction they studied was the radiative proton capture by the ^{12}C nucleus, which is relevant to the CNO cycle hydrogen burning in stars.

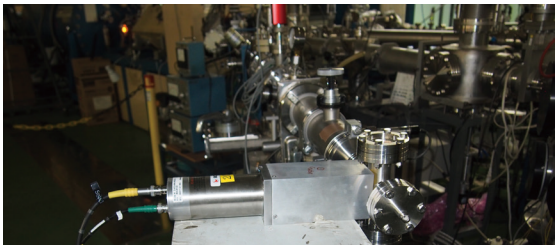

Fig. 2. Experimental setup. Proton beams from the Pelletron accelerator hit a carbon target in the small vacuum chamber, and γ rays were measured by the NaI(Tl) scintillator seen in the center of the photograph.

Figure 2 shows the experimental setup. Proton beams with 1 MeV or 2 MeV energy bombarded a carbon target, which stopped the protons to provide a so-called thick target yield of the ^{12}C(p,γ)^{13}N reaction. Two methods were employed for determination of the resonance yield: detection of "in-beam" γ rays emitted during the collision of the beam with the carbon target, and measurement of ^{13}N activities by detecting positron-annihilation photons or the 511-keV γ line, known as the "activation" technique.

An example of the γ ray spectrum is shown in Fig. 3. It is for the "in-beam" measurement with 2 MeV proton beams. Two distinct peaks, which are of relevance in the experiment, are clearly seen. The four teams could finally extract the capture cross sections for the two resonances in ^{13}N.

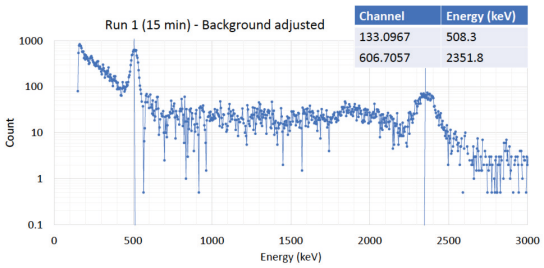

Fig. 3. An example of the γ ray spectra obtained for the "in-beam" measurement for the ^{12}C(p,γ)^{13}N reaction with 2 MeV proton beams. The two γ ray peaks correspond respectively to the two low-lying resonances in ^{13}N.

We thank all the staff members of the Nishina Center who participated and helped the Nishina School 2017.

*1 School Master
*2 Chair, Nishina School Steering Committee

IUPAP Meetings and Nuclear Science Symposium at Nihon-Bashi

H. En'yo*1

IUPAP Commission 12 (C.12) and Working Group 9 (WG.9) meetings were held at the RIKEN Tokyo office in Nihon-Bashi, Tokyo on August 29–30, 2017. Nihon-Bashi means Japan-Bridge, and the 113th element nihonium is named after Nihon (Japan or Nippon). As the name of the place suggests, the office is in a very posh central district of Tokyo and in the same building as Bank of America and Merrill Lynch.

Every two years, the meetings are organized together with the Nuclear Science Symposium (NSS), in which recent progress in nuclear physics and related developments are reviewed and discussed in the presence of invited representatives from national funding agencies worldwide. This year, representatives from South Africa, Canada, France, Italy, Australia, USA, UK, Japan, France, and China participated in the symposium.

During the symposium, special in-camera meetings were held for the representatives of funding agencies. These meetings are meant for representatives to share the progress in nuclear science and exchange the status of research in their countries, as well as to see how their efforts fit into an international framework. The agenda and slides from the symposium can be found at `http://www.triumf.info/hosted/iupap/icnp/nss2017.html`.

Shoji Nagamiya, who chaired the in-camera meetings, presented the following briefing at the end of the IUPAP WG.9 annual general meeting:

(1) The participants of the in-camera meetings recognized that an unprecedented era of nuclear science will be realized, especially with the next-generation of rare isotope beam facilities around the world.
(2) They expressed concerns regarding the effect of open-access policies on large nuclear science laboratories and the implementation of user fees.
(3) They recommended that IUPAP WG.9 may take a more explicit role in international cooperation for large-scale nuclear science projects.
(4) They recommend that IUPAP WG.9 may positively consider as an "international project" a project in which the share of responsibilities is discussed in IUPAP WG.9 from the beginning of the project by including all the stakeholder countries.
(5) They also stressed the importance of small-scale university-based nuclear science laboratories because these are essential training grounds for young scientists.

Similar discussions were also made at the IUPAP WG.9 annual general meeting. Shigeo Koyasu, the executive director of RIKEN, described the future plans for operations of the Rare Isotope Beam Facility at RIKEN. He suggested the possibility of asking the users to bear the cost (collaboration fee) not for electricity, but rather for miscellaneous expenses from the common fund for experiments.

There was a wide-ranging discussion of such user fees in the meeting. A general concern is that, if one facility implements such charges, other facilities would then be forced by their funding agencies to follow suit. This could have serious implications on the scientific productivity and mobility of the international community. Some opinions generally supported by the members were as follows: (1) Beam time should be granted based on scientific excellence. Any payment for beam time contradicts this general principle. (2) There is an established tradition among the user community to share some of the operating costs, but such sharing is not related to beam time. (3) The host institute must be very clear about what these user fees can cover. The funding agencies may prohibit the use of grant funds to pay these, which might cut off a facility's access to talented scientists around the world.

Other issues discussed in IUPAP WG.9 include reports from the Asian Nuclear Physics Association, the US Nuclear Science Advisory Committee, the Five Year Plan for TRIUMF in Canada, the Nuclear Physics European Collaboration Committee, the Latin-America Community, and the South-African Isotope Facility.

*1 RIKEN Nishina Center

International conference on nuclear physics at storage rings (STORI2017)

M. Wakasugi*1

The 10th international conference on nuclear physics at storage rings (STORI2017) was held at Kanazawa from November 13 to 18, 2017. The venue was the Kanazawa theatre (Kageki-za), which is located in the vicinity of the Kanazawa castle. The conference was hosted by RIKEN Nishina center and sponsored by Kanazawa city and Ishikawa prefecture.

(1) Participants and presentations

We had 73 participants in total, and the number of country-specific participants are listed in Table 1. We had 61 presentations in total, and the breakdown of the presentations are as follows: 27 invited talks, 15 oral talks, and 19 poster presentations. Figure 1 shows a conference photograph taken at the Kanazawa castle during the excursion.

(2) Presented topics

The conference started on 0ct. 14th (Tue.), and we had many active discussions during the week. A wide range of topics relevant to storage rings and traps were presented. On Tuesday, M. Steck presented the status of GSI and the rather new facility for decelerated RI beam, including the newly installed CRYRING, and B. Juardo presented the topics on neutron induced reaction at CRYRING. The topics that were presented on physics experiments at ESR/GSI included nuclear reactions such as a proton scattering using EXL and laser spectroscopy. There were four talks on the research going on at CERN, namely the status of the ELENA project, the anti-matter subject at the AD, the anti-proton annihilation experiment in the PANDA project, and the ISOLTRAP equipped by a MRTOF. The current status of the mass measurements using TITAN at TRIUMF was reported. The mass measurements at CSRe/IMP-CAS and the status of the new project HIAF were presented as ongoing projects in China. The other mass measurements for exotic nuclei and some related detector developments at R3/RIKEN and MRTOF/RIKEN were presented. The RIKEN RIBF facility and the achievements since its construction were overviewed by H. Sakurai, and the recent results at the SCRIT facility was reported. The status of the NICA project at JINR/Dubna was reported by E. Syresin. Atomic physics topics related to the cryogenic electrostatic storage rings at RIKEN and Max Plank were presented. The high intensity light source for nuclear physics in Romania and the muon $g-2$ experiment at Fermi Lab. were also interesting topics. Experiments on fundamental physics problems such as EDM and CP violation going on at COSY and RIKEN were presented. Finally, two theorists, A. Surzhykov and P. Indelicato, presented the capability of the QED test in a storage ring.

(3) Poster presentation

We had 19 poster presentations on Friday afternoon, and the international advisory committee gave poster awards to L. Varga (GSI), B. Wu (IMP), and H. Arakawa (Saitama U.).

(4) Excursion

In the excursion on Thursday afternoon, we conducted a tour of the Kanazawa castle and the adjacent old town, and organized an experience-based tour on gold leaf craftwork, which is a traditional speciality in Kanazawa. The participants enjoyed and learned the history of Kanazawa and the traditional culture of Japan.

(5) Next STORI2020

In this conference, the international advisory committee decided that the IPM-CSA will host the next STORI conference, which will be held in 2020 at Huizhon in China, where there is a planed cite of HIAF.

(6) Acknowledgment

We would like to specially thank the staffs of Kanazawa Convention Bureau for their great help in organizing the conference.

Table 1. Number of country-specific participants.

Country	Participants	Country	Participants
Japan	37	Canada	1
Germany	15	Romania	1
China	10	Russia	1
Italy	2	U.K.	1
Switzerland	2	Korea	1
France	2	Total	73

*1 RIKEN Nishina Center

Fig. 1. Conference photograph taken at Kanazawa castle.

International symposium on RI beam physics in the 21st century: 10th anniversary of RIBF

T. Isobe,[*1,*2] Y.X. Watanabe,[*1,*6] S. Ota,[*1,*3] N. Aoi,[*4] N. Imai,[*3] T. Suda,[*5] T. Uesaka,[*2] D. Suzuki,[*2] Y. Ichikawa,[*2] T. Nakamura,[*1,*7] K. Yoshida,[*1,*8] and K. Yoneda[*2]

The "International symposium on RI beam physics in the 21st century: 10th anniversary of RIBF" (jointly hosted by the RIBF User Executive Committee and RIKEN Nishina Center) was held on 4th and 5th December, 2017. The RI Beam Factory celebrated its 10th anniversary in 2017. Since it started the delivery of RI beams in 2007, the RIBF has successfully produced a lot of rare isotopes, and completed many in nuclear physics. In the symposium, recent progress in the physics of unstable nuclei, novel technologies in RI-beam experiments, and future activities at RIBF and other RI-beam facilities were discussed.

Fig. 1. Group photo of the symposium. The symposium was held at the large conference room of the RIBF building at RIKEN.

The number of participants was about 120. Figure 1 shows a group photo of the symposium. The program mainly consisted of four physics categories: Nuclear Structure, Equation of State, Nuclear Astrophysics, and Superheavy elements. Four theorists were invited to give review talks about the progress and perspectives of nuclear structure, nuclear astrophysics, light nuclear reactions and heavy nuclear reactions based on the physics outputs from experimental studies curried out in last decade. Further, presentations about the future the RI experimental facility were given: FRIB in USA, NuStar at FAIR in Germany, HIAF in China, and RISP in Korea. Owing to the condensed topics and presentations, the discussion regarding future RI beam physics was very stimulated in the symposium. The details of the symposium program can be found in Ref. 1).

Finally, as a special session by the RIBF user executive committee, a ceremony to present the RIBF thesis award to two winners was conducted, as shown in Fig. 2, along with a special talk by the recipients. The awards honor the achievements of Dr. Kazuyuki Sekizawa (Faculty of Physics, Warsaw University of Technology) and Dr. Jin Wu (Argonne National Laboratory) for the Ph.D theses titled "Multinucleon Transfer Reactions and Quasifission Processes in Time-Dependent Hartree-Fock Theory" (University of Tsukuba in 2015) and "Beta-Decay Spectroscopy of $Z = 55$–67 Neutron-Rich Nuclei" (Peking University in 2016), respectively. The RIBF Thesis Award was co-hosted by UEC and Nishina Center.

Fig. 2. Ceremony for RIBF theses award 2017. It was presented to Dr. Jin Wu (left) and Dr. Kazuyuki Sekizawa (right). Certificates and plates were given to winners.

*1 RIBF User Group Executive Committee
*2 RIKEN Nishina Center
*3 Center for Nuclear Study, The University of Tokyo
*4 Research Center for Nuclear Physics, Osaka University
*5 Research Center for Electron-Photon Science, Tohoku University
*6 Wako Nuclear Science Center, Institute of Particle and Nuclear Studies, KEK
*7 Department of Physics, Tokyo Institute of Technology
*8 Department of Physics, Kyoto University

References

1) https://indico2.riken.jp/event/2541/.