# Forefront Physics and Mathematics Program to Drive Transformation (FoPM) Report for the International Research Experience

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## Overview

Thanks to the support by FoPM, I could visit Spain and Germany to conduct research works for three weeks. During the first week, I stayed in Valencia, Spain to attend the Nuclear Structure and Dynamics (NSD2024) conference and gave a talk. In the remaining two weeks, I participated in an experiment at an accelerator facility at GSI in Darmstadt, Germany. These two experiences are closely related to my own research. I have learnt a lot of new things from the European nuclear physics community.

## **Conference in Valencia, Spain**

In May 27-31, I attended the Nuclear Structure and Dynamics (NSD2024) conference in Valencia, Spain. This conference focused on study of excited states, isomeric transitions and shapes of unstable nuclei. From the speakers, I learnt different physics cases related to nuclear structure. Also, the experimental methods and setups are vastly different from those I have seen in Japan. I also gave a presentation about my research. This is a precious opportunity to advertise a recently accepted paper. After the presentation, I received acclaim and questions from the audience and discussed with them about future directions.

The conference is also a nice setting for building connections. I met collaborators of an experiment conducted in 2021 in Japan who can only connect remotely. Moreover, I met collaborators who would come to Japan for future experiment. It is fascinating to meet someone who I have known for a long time and who I had not known yet.

The conference site sits in the city center which is also a heritage area (Figure 1). It is surrounded by many ancient buildings and churches. During my free time, I visited the river park which has many modern architectures, such as the opera, with other participants. Besides, the food in Valencia is superb, especially paella.



Figure 1: Ciutat Vella, Valencia

#### Experiment at GSI, Darmstadt, Germany

In June 1-17, I visited GSI, which houses a synchrotron accelerator facility, for an experiment. This experiment aimed to study the isomeric decay and beta decay of exotic nuclei with proton number  $Z \le 82$  and neutron number  $N \ge 126$ . This nuclear region southeast of lead-208 is known as the blank spot region as it is difficult to produce and identify them, thus less studied by experiments. Yet, this region has high impacts on astrophysics and nuclear structure. The uranium beam was accelerated to 1 GeV per nucleon by the heavy ion synchrotron SIS18, and then impinged on a beryllium target to produce radioactive isotopes of interest by projectile fragmentation. The secondary beam was selected and identified by the FRS separator, and then implanted in the active stoppers of the DESPEC decay station (Figure 2). There are two types of active stoppers, plastic scintillators ( $\beta$ plast) and double-sided silicon detectors (AIDA), responsible for detecting ion implantations and  $\beta$  decays. The active stoppers were surrounded by  $\gamma$  ray detectors: high-purity germanium detectors (DEGAS) and LaBr<sub>3</sub>(Ce) detectors (FATIMA). This combination offers high efficiency, high energy resolution and fast timing for  $\gamma$  ray measurements.

In the first week, I familiarized myself with the research environment and helped with the preparations. The facility is very different from RIBF in Japan, such as locations, radiation controls, detector setup, data acquisition systems, analysis computers, etc. Nevertheless, what we have done before the experiment is the same – to complete and test the detector systems. During the 5-day experiment, I was responsible for providing particle identification of exotic nuclei. I was heavily involved in the maintenance and development of the nearline analysis code. After the experiment, I helped with the calibration of the detectors.

I liked a few aspects of GSI. First, people used to have a coffee break after lunch, even during the experiment. I think it is useful to have a rest and refresh oneself during work. People can relax and talk about anything outside the experimental hall or office. Second, people like to communicate with each other. Sometimes, I could hear people randomly discussing something. I could freely join them and they are very eager to explain, especially their own research. Third, I have attended a seminar about silicon photomultiplier, which is seldom used in RIBF. The speaker offered basic details in a systematic manner. This is a small surprise for me as I learnt a lot unexpectedly.



Figure 2: DESPEC decay station

#### Outcome

This is a fruitful journey. First, I have deepened my understanding about my own research. After the conference, I gained much knowledge about nuclear structure. Also, there are many researchers doing similar research to mine, but with different approaches. Their experience is useful for me to think about future research. Second, I improved different skills related to analysis and programming which I would consider in my own research. Third, I could establish connections with other researchers from many countries. I could ask experts about technical stuff, and I could also learn from postdocs and students about their life. Finally, by working out of Japan, I have better idea about the working environment in other institutes, helping me to decide my future career. Also, it is a training for me to adapt to a different environment and culture.