Design of an Ion Source for the eSHE project Toward Pioneering Electron Scattering on Superheavy Elements

S. Naimi,[*1] T. K. Sato,[*2] K. Tsukada,[*3] P. Schury,[*4] Y. Ito,[*3] H. Haba,[*1] Y. Komori,[*1] T. Ohnishi,[*1] and T. Uesaka[*1]

Theoretical study shows that the central depression in the nucleonic density is enhanced in superheavy nuclei and is correlated with the symmetry energy.[1)] Electron scattering is a very reliable technique to probe the charge density in heavy nuclei.

The electron scattering on SuperHeavy Elements project, or eSHE project for short, aims at pioneering electron scattering on heavy and superheavy nuclei by creating a missing link between two powerful facilities at RIKEN, the AVF cyclotron and the SCRIT facility. The AVF facility can produce heavy and superheavy nuclei. The SCRIT facility is dedicated for electron scattering on Rare Isotopes (RIs).[2)] The eSHE project mission consists in bringing RIs produced at AVF to the SCRIT facility to perform electron scattering. For this purpose, we prepare a target from RIs produced at AVF, which is then transport to SCRIT facility where the target could be inserted into the oven of ion source designed for this purpose. Since the preparation and transport of the target will take time, only RIs with long lifetime (at least few hours) are considered. Figure 1 shows nuclei heavier than ^{208}Pb that could be reached by this method. However, the feasibility of SHEs will be limited by the production yield even for long-lived nuclei and a more efficient method is needed. To test the feasibility of this method, we plan to conduct a pilot experiment with ^{225}Ac with a half-life of 10 days. This isotope can be produced with high intensity at AVF via the reaction ^{226}Ra(d, 3n)^{225}Ac, with 24 MeV and 10 μA deuterium beam. To perform electron scattering experiment for 10 hours, a target of 0.3–3 GBq ^{225}Ac is needed. Due to the low ionisation potential of Ac element, it is possible to achieve high ionisation efficiency with a surface ion source type.[3)] Design of such ion source is shown in Fig. 2, where a double valve system is used to allow insertion of RIs target into the oven of the ion source without breaking the vacuum. The ion source is now under construction and it will be commissioned firstly offline with Lanthanum, which is available commercially as La_2O_3 powder. The online commissioning will be performed with ^{225}Ac produced at the AVF. The aim is to estimate the total efficiency and production, which will determine the feasibility of electron scattering at SCRIT. To achieve the necessary accuracy for electron scattering study, a beam of $10^6 - 10^7$ ions per second is needed for a period of one month.

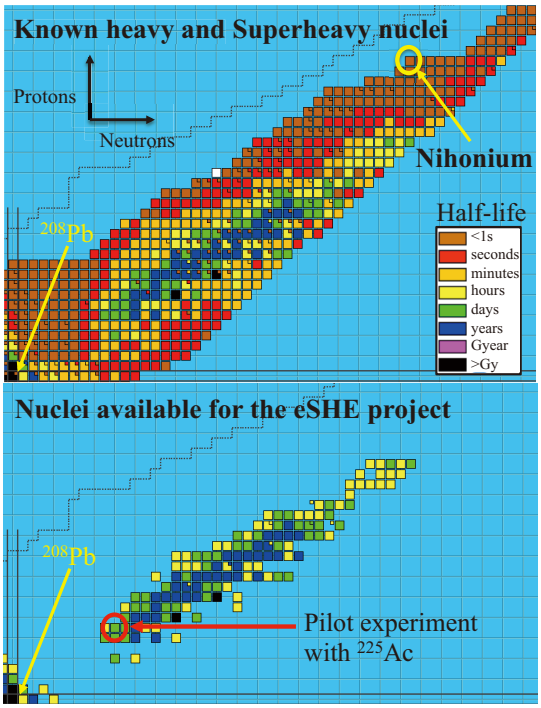

Fig. 1. (Top) All known nuclei heavier than ^{208}Pb isotope (Bottom) Nuclei with long enough lifetimes that would be available for the eSHE project. A pilot experiment will be conducted with ^{225}Ac.

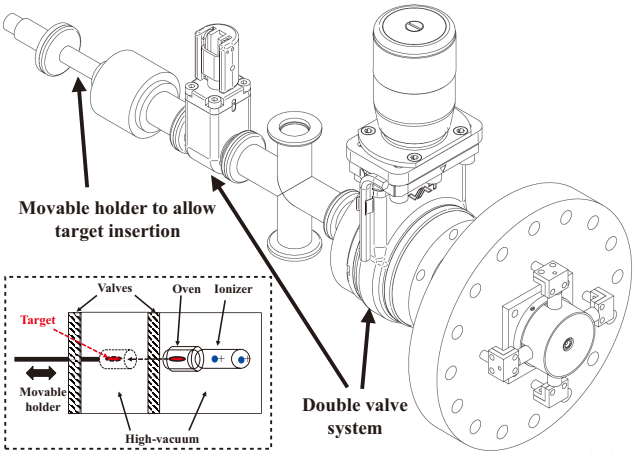

Fig. 2. Design of an ion source for Ac ionization. In the lower left side is shown the schematic of insertion of RIs target into the oven without breaking the vacuum.

*1 RIKEN Nishina Center
*2 Research group for Heavy Element Nuclear Science, JAEA
*3 Research Center for Electron Photon Science, Tohoku University
*4 WNSC, IPNS, KEK

References

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