Status of the mass measurement of neutron-rich nuclei at $A \sim 50$–60 using SLOWRI/ZD-MRTOF

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An RF carpet-type helium gas cell combined with an MRTOF mass spectrograph, the ZD-MRTOF, has been installed downstream of the ZeroDegree spectrometer at the RIBF and is under operation as a collaboration between the RNC and KEK/WNSC. Mass measurement using the ZD-MRTOF can be performed parasitically during other experiments at BigRIPS. During experiments for gamma-ray spectroscopy (HiCARI campaign), the first online commissioning of the system and mass measurements of neutron-rich nuclei were performed symbiotically using the ZD-MRTOF system.[1,2] The detailed experimental information including the experimental setup is available in other papers.[3–6] Overall, masses of more than 70 isotopes have been measured successfully. We have completed the analysis and determination of masses of the measured isotopes.

Figure 1 shows an example of a measured TOF spectrum for isobars with $A = 56$. The ZD-MRTOF yielded a mass resolving power of approximately 500,000 during the online commissioning, resulting in high precision mass determinations.

At approximately $A = 50$–60, the masses of 15 radioactive neutron-rich nuclei have been determined. Figure 2 shows the measured nuclei indicated with colored circles on a nuclear chart.

For nuclei enclosed with green circles, the uncertainties of masses determined with the MRTOF are less than

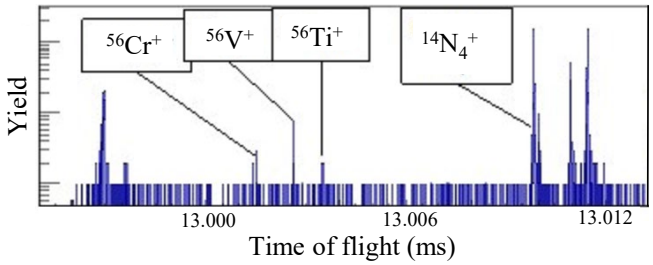

Fig. 1. Example of measured TOF spectrum on isobars with $A = 56$.

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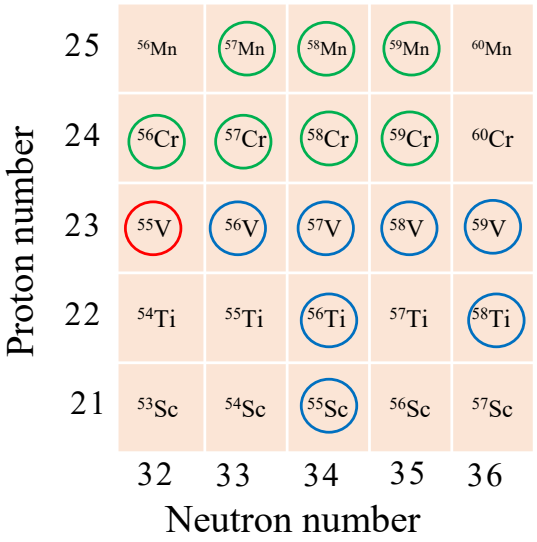

Fig. 2. Nuclei at approximately $A = 50$–60, for which the masses were measured using the ZD-MRTOF (circles with colors: see text).

30 keV but larger than the uncertainties of AME2020. These determined masses are well consistent with the values on AME2020 within their uncertainties. For ^{55}V, indicated with a red circle, the uncertainty is approximately 90 keV owing to the low statistics. For nuclei enclosed with blue circles, the uncertainties are less than 30 keV and are smaller than the uncertainties of AME2020. It is interesting to note that the values of masses of ^{58,59}V and ^{58}Ti determined using the ZD-MRTOF deviate from ones of AME2020 by 100 keV or more. As a result, the uncertainties of the masses on seven nuclei can be improved significantly.

These updated mass values enable us to discuss the magicites for $N = 32$ and 34 of Sc, Ti, and V isotopes, using two neutron separation energies, empirical shell gaps, and other finite difference of binding energies. A detailed discussion is in progress.

References

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