Multi-mass passing mode using an in-MRTOF deflector for purified detection of several isobar chains

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One of the key points for successful MRTOF-MS mass measurements is the in-MRTOF deflector (IMD). Among the modifications of the new ZD MRTOF-MS reported in Ref. 1), IMD operation mode has been extended to allow for the safe passing of more than one mass unit. This has not been reported in detail so far, and will be discussed here in this article. The principle of an IMD is known since 2009, where such a deflection unit has been used for atomic cluster science.[2] The IMD is an ion kicker located in the center region of (presently) the ZD MRTOF-MS, the SHE-Mass setup (fission fragment studies by S. Kimura[3]), and the KISS MRTOF-MS. It was initially operated using a trigger from a signal generator running with the same frequency as that of the revolving ion species to be protected, *i.e.* to ensure that the deflection field was always in the "off" state when the ion passed the impact region.

Following the first campaign of the ZD MRTOF system in the year 2020, the procedure has been renewed by an implementation of the trigger mechanism into the WNSC sequencer. As the revolution times in MRTOF mass spectrometry are pre-determined by the electric fields, the times to cross the impact region of the IMD can be calculated accurately if the revolution period time of a well-known ion has been measured before. By programming, the trigger sequence can be established to protect an arbitrary number of ions by a NOR condition for the logic of the "on" time of the deflector. Only if none of the ion species to be protected crosses the impact region, the deflector goes in the "on" state. If the region is liberated from the wanted ions, all other crossing ion species (having different lap times) are eliminated (see Fig. 1). In that way, several ion species can be detected at the same time, while the total number of laps may differ between them. This has been used to detect $A = 73$ and $A = 74$ isobars (including Ni isotopes) simultaneously (see Fig. 2).

To make this procedure useful, two limitations have to be considered: On one hand, too many species to be protected cause excessive "off" time of the deflector, which leads to the survival of unwanted ion species. If the spectrum should be background free, the "on" time should be as long as possible in average. On the other hand, a limitation comes from the placement of the protected species in the spectrum. The identification must be unambiguous, which prohibits excessive overlapping of different isobar chains at similar times-of-flight. In that way, the practical application for a larger number of masses can be extended by pre-knowledge of the expected isobars at each mass number. The multiple-mass passing mode facilitates to save expensive beam time and will be further exploited in future experiments.

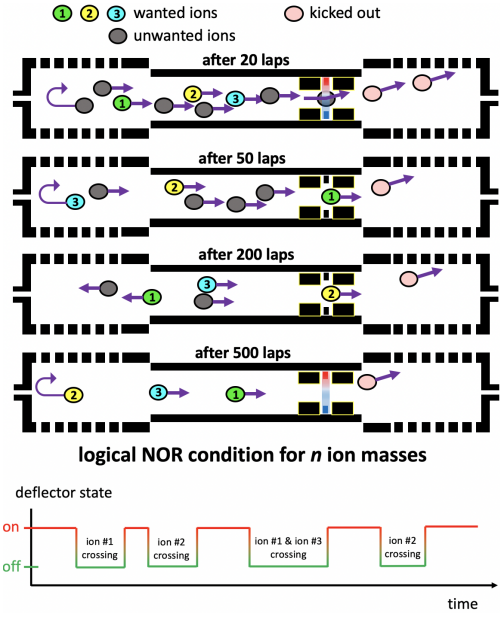

Fig. 1. Top: Scheme of the protection of three different mass units, while ejecting all other components in the MRTOF-MS. Bottom: Illustration of the logic NOR structure pre-programmed on the WNSC sequencer.

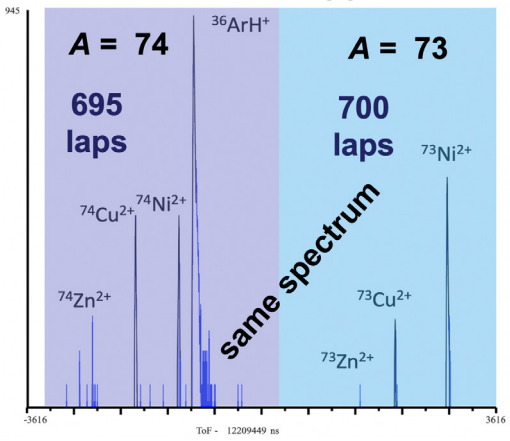

Fig. 2. Mass measurement of ^{73}Ni and ^{74}Ni at the same time using the IMD to reject all other mass units.

References

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