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Development of isobar suppression system using Laser in Accelerator mass spectrometry

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For Accelerator mass spectrometry (AMS), isobar separation is quite important to improve measurement accuracy and the background. In order to suppress isobar interference, gas-filled magnet or gas counter have been conventionally used [1,2]. Nuclides of interest are separated from isobars by interaction between ions and materials in these devices.

In the 1980s, Berkovits et al. tried to remove stable isobars before acceleration with laser light[3]. In this method, the difference of the electron affinity (EA) was utilized for isobar suppression. If the EA of the nuclide of interest is higher than the EA of the isobar nuclide, only negative isobar can be selectively neutralized by photodetachment with photons of energy, which is higher than the EA of isobar nuclide but lower than the EA of the nuclide of interest. Consequently, only nuclide of interest can be injected into the accelerator and isobar suppression can be effectively achieved. However, due to the limited laser performance, the laser-ion interaction time was too short to suppress isobar sufficiently at that time. Therefore, this technique has not been in practical use yet.

Recently, as laser improved in quality and the way to increase the laser-ion interaction time effectively was proposed, development of isobar suppression system is going on. For example, Liu et al. developed the RFQ ion cooler to slow ions [4]. This apparatus is filled with a buff gas and ions collide with gas molecules, which results in the deceleration of ions and the long interaction time. This photodetachment system can remove isobar interference in AMS measurements for nuclides, such as Cl-36 (EA=3.62eV) with S-36 (EA=2.08eV), Ni-59 (EA=1.156eV) with Co-59 (EA=0.661eV) [4]. Furthermore, even if the EA of the nuclide of interest is lower than the EA of the isobar nuclide, photodetachment could be useful by converting the nuclides into the molecular ions and reversing these electron affinities.

In order to make laser interact with ion beams effectively, the ion beam optics including the devices like the ion cooler should be optimized. This device will be installed after the electrostatic deflector or after the injection magnet in the beam line. In this study, as a preliminary step, optimization of the ion beam optics including some components to decelerate ion will be dicussed.

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