Ion-Laser InterAction Mass Spectrometry and the quest for AMS of ^{182}Hf

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The long-lived trace isotope ^{182}Hf ($T_{1/2}$ = 8.9 Ma) is of high astrophysical interest as its potential abundance in environmental archives would provide rare insight into heavy element nucleosynthesis in recent r-process events in the vicinity of our planet. Despite substantial efforts, however, it could not be measured at its natural abundance level with conventional AMS so far due to strong isobaric interference from stable ^{182}W. The new Ion Laser InterAction Mass Spectrometry (ILIAMS) technique at the Vienna Environmental Research Accelerator (VERA) tackles the problem of elemental selectivity in AMS with a novel approach. It achieves near-complete suppression of isobar contaminants via selective laser photodetachment of decelerated anion beams in a gas-filled radio frequency quadrupole (RFQ) [1,2]. The technique exploits differences in electron affinities (EA) within elemental or molecular isobaric systems neutralizing anions with EAs smaller than the photon energy. In addition, collisional detachment or chemical reactions with the buffer gas can further enhance anion separation.

In this contribution, we will highlight the potential of this new technique based on recently conducted AMS-measurements of ^{90}Sr ($T_{1/2}$ = 28.64 a), where ILIAMS achieves an isobar suppression factor $>10^7$. The application of ILIAMS improves the detection limit by a factor 40 compared to the previous AMS-benchmark. We will then present first results with this approach on the even more challenging detection of ^{182}Hf. With He+O_2 mixtures as buffer gas in the RFQ, suppression of $^{182}WF_5^-$ vs $^{180}HfF_5^-$ by $>10^5$ has been demonstrated. Mass analysis of the ejected anion beam identified the formation of oxyfluorides as an important reaction channel. The overall Hf-detection efficiency at VERA presently is 1.4×10^{-3} and the W-corrected blank value $^{182}Hf/^{180}Hf = (3.4 \pm 2.1) \times 10^{-14}$. In addition, a survey of several sputter materials for highest negative ion yields of HfF_5^- has been conducted. Finally we will give an outlook on ways to proceed in order to detect ^{182}Hf at astrophysical levels.

[1] M. Martschini et al., *Int.J. Mass Spect.* **415**, 9 (2017).
[2] M. Martschini et al., in press, doi: 10.1016/j.nimb.2019.04.039.