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# Effcient in-trap laser-induced loading of rare species into an EBIT for high- precision mass spectrometry at Pentatrap

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The electron capture (EC) decay of $^{163}$Ho to $^{163}$Dy is a promising candidate for the determination of the electron neutrino mass in the sub-eV range. For this purpose the ECHo collaboration [1] aims to perform a calorimetric measurement of the $^{163}$Dy$^{*}$ de-excitation spectrum. With its Penning-trap setup the \textsc{Pentatrap} [2] experiment performs a precision mass measurement of the mother and daughter nuclide with a relative mass-ratio uncertainty of $10^{-11}$, thus contributing an independent value of the energy available for the EC decay ($Q$-value). To achieve such a precision, highly charged ions are necessary which can be produced in electron beam ion traps (EBIT).
To cope with the strongly limited amount of $^{163}$Ho available, an efficient in-trap laser-induced loading technique into a Heidelberg compact EBIT [3] was developed for very rare atoms. Ions of various mass domains *A=40* to *A=209* have been successfully produced, in particular charge states of up to 45+ have been achieved for $^{165}$Ho using a sample size of only about $10^{12}$ atoms (about 0.27 ng). These small samples lasted for the production of more than 30000 HCI bunches, each containing thousands of Ho ions.
The EBIT was recently connected to the *Pentatrap* beam line and is currently being commissioned for the measurement of the mass ratio of $^{163}$Ho and $^{163}$Dy.

[1] Gastaldo, L. et al., Eur. Phys. J. Special Topics 226, 1623 (2017)

[2] Repp, J. et al., Appl. Phys. B 107, 983 (2012)

[3] Micke, P. et al., Rev. Sci. Instrum. 89, 063109 (2018)

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