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Ba-ion Extraction From High Pressure Xe Gas for Double-beta Decay Studies with nEXO

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An RF-only ion funnel has been developed to efficiently extract single Ba ions from a high-pressure (10 bar) xenon gas into vacuum. Gas is injected into the funnel where ions are radially confined by an RF field while the neutral gas escapes. Residual gas flow alone (without any DC drag potential) transports the ions longitudinally through the funnel. In the downstream chamber the ions are captured by a sextupole ion guide and delivered to an ion detector. The xenon gas is captured by a cryopump and then recovered back into storage cylinders for future use.

With the current setup ions were extracted from xenon gas of up to 10 bar and argon gas of up to 7.8 bar. These are the highest gas pressures ions have been extracted from so far. The ions were produced by a Gd-148 driven Ba-ion source or a Cf-252 fission source placed in the high pressure gas. The ion transmission has been studied in detail for various operating parameters. A mass spectrometer has been used for mass-to-charge identification of the extracted ions. This identification is being improved to further investigate the properties of the funnel and to measure the Ba-ion extraction efficiency of this setup.

This approach of ion extraction is intended for application in a future large-scale Xe-136 neutrinoless double-beta decay (0nbb) experiment. The technique aims to extract the bb-decay product, Ba-136, from the xenon gas and detect it unambiguously and efficiently. This individual identification of the decay product allows for an ideally background-free measurement of 0nbb by vetoing naturally occurring backgrounds. This identification enables a higher level of sensitivity to the 0nbb decay half-life and thus is a more sensitive probe of the nature of the neutrino.

Primary author: BRUNNER, Thomas (McGill and TRIUMF)

Co-authors: Mr FUDENBERG, Daniel (Stanford University); Dr GRATTA, Giorgio (Stanford University); Dr DILLING, Jens (TRIUMF); Mr MURRAY, Kevin (McGill University); Dr VARENTSOV, Victor (Institute for Theoretical and Experimental Physics and FAIR); Mr LAN, Yang (TRIUMF and UBC)

Presenter: BRUNNER, Thomas (McGill and TRIUMF)

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