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The development of an accelerator-driven barium ion source for barium-tagging in liquid xenon

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The proposed nEXO experiment will use a tonne-scale liquid xenon (LXe) time projection chamber that aims to uncover properties of neutrinos via the observation of Xe-136 neutrinoless double beta decay ($0\nu\beta\beta$), with a projected half-life sensitivity of 1.35×10^{28} years at the 90% confidence level, after 10 years of live time. Such observation of lepton number violation would point to new physics, beyond the Standard Model and imply that neutrinos are their own antiparticles. The collaboration has been pursuing the development of new technologies to further improve the detection sensitivity of nEXO, using techniques such as barium-tagging. This technique aims to locate single Ba ions within a LXe volume, extract and further separate them from the LXe, and identify their mass. Ba-tagging would allow for an unambiguous identification of true $\beta\beta$-decay events, and if successful would result in an improvement to the nEXO detection sensitivity by a factor of 2-3. Other experimental LXe-based efforts may also benefit from the development of Ba-tagging. Ion extraction methods are under development by other groups within the nEXO collaboration; these methods require a Ba ion source for future efficiency testing. The group at TRIUMF is developing an accelerator-driven ion source to implant radioactive ions inside a volume of LXe. In Phase I of this development, following implantation of radioactive ion beam into LXe, ions will be extracted using an electrostatic probe for subsequent identification using γ-spectroscopy. In this contribution, a status update will be provided on the commissioning for Phase I of the Ba-tagging setup at TRIUMF.

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