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Ba-Tagging Technique for Liquid Xenon Based Neutrinoless Double-Beta Decay Searches

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Neutrinoless double-beta decay ($0\nu\beta\beta$) is a hypothetical, Standard-Model forbidden nuclear process in which two beta decays occur simultaneously without the emission of antineutrinos. Its observation would imply the Majorana nature of neutrinos, proving that they are their own antiparticles, and provide critical insight into the origin of the matter-antimatter asymmetry in the universe. The nEXO experiment aims to search for this lepton-number violating decay in the double-beta decaying isotope ^{136}Xe, deployed at 90% enrichment in a 5 tonne liquid xenon (LXe) time projection chamber. The experiment's projected sensitivity to $0\nu\beta\beta$ half-life is 1.35×10^{28} years at a 90% confidence level after 10 years of data taking.

Leveraging nEXO's ability to reconstruct events within its detector volume, the ^{136}Xe $0\nu\beta\beta$ daughter ^{136}Ba can be extracted and identified from the event location. A positive identification of ^{136}Ba will help to exclude most background events. Such an active background rejection could boost the sensitivity of nEXO by a factor of $2-3$ compared to its current projection. This technique is called Ba-tagging and is being developed as a potential future upgrade to nEXO. The scheme described in this talk outlines our approach to extracting a single Ba ion using a capillary, isolating the ion using radio frequency (RF) technology, and identifying the ion to be ^{136}Ba^{+} using laser fluorescence and mass spectroscopy. The current status of the scheme, the development of an in-LXe ion source, and future applications of this technique will be discussed.

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