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Imaging of single Ba atoms and Ba^+ ions in solid xenon for barium tagging in next-generation ^{136}Xe double beta decay experiments[1]
WILLIAM FAIRBANK, JAMES TODD, DAVID FAIRBANK, ALEC IVERSON, TREY WAGER, Colorado State University, NEXO COLLABORATION COLLABORATION — The identification, or "tagging" of the barium-136 daughter atom that results from double beta decay of xenon-136 provides a promising technique for elimination of all backgrounds except 2 double beta decay in future generations of ^{136}Xe neutrinoless double beta decay experiments. We have demonstrated that individual Barium atoms can be imaged and counted in two of four matrix sites in solid xenon.[a] We report new progress towards single Ba^+ ion imaging in the one favored matrix site and imaging in the remaining Ba sites. The Ba tagging scheme being developed utilizes a cryogenic probe to trap the ^{136}Ba daughter atom in solid xenon and extract it from a liquid xenon time projection chamber, such as the nEXO design concept. The barium atom is then tagged via fluorescence imaging in the solid xenon matrix. When perfected, a count of 1 Ba or Ba^+ peak indicates a real double beta decay event; a zero count is evidence of a background event. An important feature of the method is that any residual Ba atoms on the probe surface do not create an observable signal, only those that are captured in the solid xenon. [a]C. Chambers et al., Nature 569, 203 (2019).

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