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Imaging of single Ba atoms and Ba+ ions in solid xenon for barium tagging in next-generation 136Xe double beta decay experiments

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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-neutrino double beta decay in future generations of 136Xe 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. 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 136Ba 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. 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.

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