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Search for the Two Neutrino Double Electron Capture with XENON1T

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XENON1T, widely known as the next step in the challenging hunt for direct dark matter detection, provides the possibility for the study of interesting physics beside its main purpose. One promising example for this is the search for different beta decay modes of ^{124}Xe. Here the process of Two Neutrino Double Electron Capture (2νDEC) is the first one to look for as it is predicted by the Standard Model and is favored compared to any process involing the creation of positrons (e.g $2\nu\mathrm{EC}\beta^+$, $2\nu\beta^+\beta^+$). However, an observation of this decay would be the first direct evidence for this decay mode, since so far there is only an indication for ^{78}Kr and an indirect observation for ^{130}Ba. The detection for ^{124}Xe would shed light on uncertainties coming from nuclear matrix element(NME) calculations and can help to distinguish the viability of different NME determination methods.
For ^{124}Xe there is only a lower limit on the half-life set by the XMASS experiment at 4.7×10^{21} yrs. A previously conducted search using the XENON100 data showed the possiblity of the XENON detectors to search within this region due to the advantageous low background. For XENON1T the background around the signature of this decay at around
64 keV has been improved by more than one order of magnitude and combined with the large mass of the detector (>1 ton fiducial) it will be the most sensitive detector in the world and has a fair chance to find the 2νDEC. Since the data used for this search is the same as for the dark matter run, there has been data acquired since November 2016 and the results of this data set will be shown within this contribution. The work of the contributor is supported by BMBF under contract number 05A14PM1 and DFG (GRK 2149).

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