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Development of an active Transverse Energy Filter (aTEF) with angular-dependent electron detection for background reduction at the KATRIN experiment

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The KATRIN experiment aims at the direct measurement of the neutrino mass scale via precision endpoint spectroscopy of tritium β-decay. The current upper limit on the neutrino mass set by KATRIN is 0.8 eV/c² (90% C.L.) (Nature Physics 18, 160–166 (2022)). Despite advances in background reduction, the elevated background level prohibits to achieve its target sensitivity of 0.2 eV/c² (90% C.L.).
Our investigations showed that the special nature of the background allows in principle differentiating background (small pitch angles) from β-decay electrons (large pitch angles). Therefore, one option to reduce the background is by implementing an "active Transverse Energy Filter" (aTEF, Eur. Phys. J. C 82, 922 (2022)), which discriminates electrons at the detector based on their pitch angle. First aTEF prototypes fabricated at the University of Münster show the expected angular-selective electron detection.
This contribution presents the concept of an active Transverse Energy Filter, its fabrication process and the performance of current prototypes in a test setup. It furthermore gives an outlook on the potential for background reduction and the related sensitivity improvement from an implementation of an aTEF at KATRIN.
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