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# Measurement and reduction of low-level radon background in the KATRIN experiment

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The KArlsruhe TRItium Neutrino (KATRIN) experiment is a large-scale experiment for the model independent determination of the mass of electron anti-neutrinos with a sensitivity of 200 meV/c^2. It investigates the kinematics of electrons from tritium beta decay close to the endpoint of the energy spectrum. Low statistics at the endpoint requires an equally low background rate below 10^-2 counts per second. The measurement setup consists of a high luminosity windowless gaseous tritium source (WGTS), a magnetic electron transport system with differential and cryogenic pumping for tritium retention, and an electro-static spectrometer section (pre-spectrometer and main spectrometer) for energy analysis, followed by a segmented detector system for counting transmitted beta-electrons.

The KATRIN measurement requires a total background rate below 10^-2 counts per second. Initial measurements at a test setup with the KATRIN pre-spectrometer, revealed a rate well above this limit, coming from radon decays inside the spectrometer volume. Two main sources have been identified, the vacuum getter pump, which emanates mainly Rn-219 with a half-life of 4 s, and the stainless steel of the vacuum chamber of the spectrometer, emanating Rn-220 with a half-life of 56 s. Long-lived radon isotopes are of no concern, since they can be pumped out of the sensitive volume before they decay. Neutral radon atoms are able to penetrate deep into the magnetic flux tube of the spectrometer where they eventually decay. Electrons, produced in various processes during or after the alpha decay of Rn, are guided magnetically to the detector where they contribute to the background rate. Of particular importance are electrons emitted in processes such as shake-off, internal conversion of excited levels in the Rn daughter atoms and Auger electrons. Low-energy electrons (< 100 eV) can directly leave the spectrometer towards the detector. High-energy electrons are usually stored magnetically for hours inside the spectrometer, where they can create thousands of secondary electrons via subsequent ionization processes with residual gas molecules. Thus already one radon decay can produce enough background events for one day.

This talk will give an overview of observed Rn sources and subsequent processes in the KATRIN spectrometer and describes different passive and active counter measures, which have been tested at the pre-spectrometer to reduce the Rn induced background rate. Direct consequences for the design of the large main spectrometer (volume 1240 m^3) are discussed.

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