KSETA report 2019

Dominic Hinz

I started my doctoral studies in February 2019 at the KATRIN experiment. My further research focuses on background studies in the KATRIN spectrometers due to intrinsic radioactivity, which is directly connected to my master's thesis, which was finished also at KATRIN.

In spring last year, the first official neutrino mass scan data were taken with the complete beamline of the KATRIN experiment. Here, radioactive tritium gas decays within a 70m long beamline at the source section and the beta electrons which carry the neutrino mass information are magnetically guided to the detector. By changing the high voltage on the spectrometers, different regions of the tritium spectrum can be measured, also the background as we increase the blocking voltage to a value higher than the maximum tritium beta electron energy. Hence my task was primarily the data analysis of background events during neutrino mass scans, since many parameters of the background events affect the measurement of the neutrino mass. Namely, the global rate of electrons, the dependence on the high voltage of the main spectrometer, or the uncertainty of non-poissonian fluctuations. Those fluctuations arise from radioactive decays of radon in the fluxtube volume in the main spectrometers, were the beta electrons are guided through. Radioactive radon decays release electrons with energies up to several keV which get magnetically stored within the spectrometer due to a magnetic bottle effect between strong magnets. In addition, this uncertainty of non-poissonian events was during the first measurement campaign the second largest systematic next to the statistical one. Data analysis of this effect is essential, whereby analysis and simulation tools such as Monte-Carlo studies are used. This one task of my doctoral research.

Besides the background events due to radioactive decay within the fluxtube volume, we know that intrinsic contamination of Pb-210 within the stainless steel of the main spectrometer also contributes to the background events within the volume. The long-living isotope Pb-210 decays to Po-210 which decays via an alpha decay to stable Pb-206. Thereby, the double ionised recoil propagates through the material and can sputter atoms from the surface which overcome the electric field of the inner electrode system, which is not possible for electrons. Those sputtered atoms are assumed to be in excited states of unknown specification but must exist long enough the get ionised within the fluxtube volume, either by black body radiation or spontaneously by autoionisation. The phenomen of the formation of such excited atoms by sputtering of surfaces due to the radioactive recoil nucleas was already topic of my master’s thesis but is still highly interesting for the future of the KATRIN experiment. And therefore, also part of my doctoral research by simulations of the generation characteristics as well as ionisation mechanisms of such atoms.