Contribution ID : **57** Type : **Poster**

The Dortmund Low Background Facility

Wednesday, 28 September 2016 14:50 (0:02)

Content

The Dortmund Low Background Facility (DLB) is a high-purity germanium gamma-ray spectrometry laboratory situated above ground, that reaches sensitivities well below 1 Bq/kg.
In contrast to most other low-background screening facilities the DLB is not located in a (deep) underground laboratory, but above ground on the campus of the University of Dortmund. This gives the possibility for easy and quick access to the facility for maintenance and inducing new samples. It was set up initially to support the neutrinoless double beta-decay experiment COBRA at the LNGS, Italy.
An outer shielding is constructed artificially, using about 400 t of concrete and iron, which adds up to an overburden of 10 mwe. This is sufficient to shield the hadronic component of cosmic-rays and reduces the remaining muonic component by a factor of two. For shielding against the ambient environmental radiation (such as thorium and uranium from the surrounding constructions and the radon content in the air of the laboratory) a multi-layer inner shielding is build. It is designed especially for the application above ground, thus the neutron absorber is placed inside the lead layers of the shielding, suppressing the neutron flux at the position of the germanium detector considerably. Although the flux of cosmic muons is already reduced by the outer shielding, the remaining muons make an active muon veto necessary. The muon veto is made of thin plastic scintillators and photomultiplier tubes. The scintillators are rather thin, which results in an insufficient signal discrimination with just one scintillator. A muon detection efficiency of about 99 % has been achieved by using a coincidence setup with two layers of separate scintillators. The muon veto reduces the integral background rate recorded with the germanium detector by more than one order of magnitude by rejecting about 96 % of the muon-induced signals inside the germanium crystal.
The background with the finalized setup is lowered by more than three orders of magnitude compared to the unshielded case. The remaining integral background count rate between 40 keV and 2700 keV is 2.01(1) counts/(kg min), which is comparable to the background level of facilities with shallow overburden like the Felsenkeller in Dresden, Germany, with 100 mwe and 2.04 counts/(kg min), or the Garching Underground Laboratory in Garching, Germany, with about 10 mwe and 1.2 counts/(kg min). For comparison the rates are normalized to the detector crystal mass. Assuming a typical sample geometry, the detection limits can be calculated to be well below the design goal of 1 Bq/kg. Depending on the isotope under investigation, limits in the range of 10 mBq/kg can be reached with just one week of measurement time. In order to calculate activities, extensive Monte-Carlo simulations based on GEANT4 are performed to estimate and test the detection efficiencies.
The DLB enables radiopurity pre-screenings by the DIN ISO 11929:2011 standard within a short time period in order to decide whether a more sensitive but more expensive screening facility is necessary.
Currently, potential extensions of the facility are under investigation for further improvement of the spectrometry measurements, including pulse shape analysis with an FADC-based readout system. Furthermore, Monte-Carlo studies are conducted to estimate the performance of an additional Anti-Compton shield to be integrated to the present setup.

About the Presenter

Christian Nitsch will be the presenter.
He is a PhD student in his second year and has been working on the Dortmund Low Background Facility (DLB) for the last four years. Whereas the focus for Bachelor's and Master's thesis (in the first two years) was on completing and upgrading the muon veto of the DLB, he is now operating the germanium detector, performing the measurements and working on further upgrades of the detector-system.
He is the primary author of a recent publication, which is presenting the status of the facility in 2015, before the completion of the muon veto.
Furthermore he is a member of the COBRA (neutrino-less double beta decay-search) collaboration and has performed on-site shifts at the LNGS, Italy, working on the upgrade of the COBRA demonstrator-setup.

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Session Classification : Radiometrics

Track Classification : Radiometrics