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(alpha, n) Cross Section Data Improvement Needs for Next Generation Low-Background Neutrino and Dark Matter Experiments

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Next generation low-background neutrino experiments and generation-3 dark matter experiments will not only have to be located deep underground to shield cosmic induced backgrounds, but the sheer size of these next generation detectors can bring forth unprecedentedly large excavation costs. Therefore, it will be challenging to have an abundantly large passive and/or active shield around these large-sized detectors and cost effective solutions will have to be found. Crucial for such assessments is the accurate prediction of residual backgrounds that could enter the fiducial volumes of these detectors. Radiological neutrons from the surrounding rock and shot/concrete are hereby most critical, but also neutrons produced in the detector materials themselves, such as steel structures, insulating foam layers, internal cables, electronics components, etc. or the target material. It is relatively straightforward to assess neutron production yields from spontaneous fission of e.g. radiological U-238 concentrations in the rock or detector materials. But to date, it is still difficult to ascertain from U-238, Ra-226 and Th-232 concentrations the precise (alpha, n) production yields and neutron energy spectra that are induced by alpha-ray energies of up to about 9 MeV. These alpha-rays arise from alpha decays in the early and late U-238 decay chain, and the Th-232 decay chain, respectively. The uncertainties in the (alpha, n) production yields stem mostly from a lack of measurements and/or uncertainties in the existing measurements of (alpha, n) cross sections on many relevant target isotopes. More precise measurements of (alpha, n) cross sections in the alpha-ray energy range of up to 10 MeV on certain critical target isotopes would greatly mitigate the uncertainty on radiological neutron backgrounds for next generation neutrino and dark matter experiments and thus could in turn greatly help saving costs.

Primary author: REICHENBACHER, Juergen (South Dakota School of Mines and Technology)

Presenter: REICHENBACHER, Juergen (South Dakota School of Mines and Technology)

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