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Projection of purification performance in LXeTPC for the RELICS experiment

The RELICS (REactor neutrino LIquid xenon Coherent elastic Scattering) experiment employs a dual-phase liquid xenon time projection chamber to search for Coherent Elastic Neutrino-Nucleus Scattering ($\text{CE}\nu\text{NS}$) induced by reactor neutrinos. To detect these sub-keV nuclear recoils and minimize signal attenuation, it is critical to maintain a sufficiently low impurity concentration in the detector. To this end, we have developed a comprehensive purity evolution model that describes impurity migration inside the detector, taking into account the outgassing of electronegative impurities from materials and incorporating non-uniform transport mechanisms of impurities, including circulation, vaporization, and condensation. The model is validated using data from a dedicated prototype detector. Based on this validated model, projections for the purification performance of the upcoming RELICS detectors are provided. We also expect this model to be applicable to other similar experiments that require strict purity control.

Primary author: YU, Jiachen (University of Science and Technology of China)

Presenter: YU, Jiachen (University of Science and Technology of China)