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Muon-induced backgrounds in the AMoRE-II underground detector

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Muon-induced backgrounds present a substantial challenge for rare-event searches like neutrinoless double beta decay. To substantially reduce these backgrounds, the AMoRE-II experiment is located approximately 1,000 meters underground at the Yemilab facility in Korea. AMoRE-II employs low-temperature lithium molybdate crystal detectors along with complementary detection systems, including a plastic scintillator muon detector (PSMD) and a water Cherenkov detector (WCMD), to achieve unprecedented sensitivity levels.

This preliminary investigation addresses muon bundles—simultaneous arrivals of multiple muons originating from high-energy cosmic ray interactions in Earth's atmosphere—and evaluates their contributions relative to the overall muon-induced background observed in AMoRE-II. Employing comprehensive Monte Carlo simulations utilizing Geant4 and MUTE software frameworks, along with initial analyses of experimental data obtained predominantly from PSMD and WCMD, this study aims to quantify the occurrence rates, multiplicities, and energy deposition characteristics of muon bundles at the detector site.

In this presentation, we outline our methodological approach, present initial simulation outcomes, and provide preliminary quantitative assessments of muon bundle-induced backgrounds. While muon bundles are expected to comprise a minor fraction of the total muon-induced background, their precise characterization is critical for developing an accurate background model and effective mitigation strategies. These preliminary results lay the groundwork for future in-depth examinations of muon-induced backgrounds in the AMoRE-II experiment.

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Author: SEO, Jeewon

Presenter: SEO, Jeewon

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