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Ultra Low Background Radon Measurement System and Radon Removal Techniques for Rare Event Experiments

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In the pursuit of ultra-low background experiments, minimizing radon levels is crucial. This research presents significant advancements in radon detector sensitivity, surface treatment technologies, and radon removal systems. We achieved a background level of 0.07 ± 0.03 mBq in a 7.4L chamber and 0.03 ± 0.01 mBq in a 12.33L chamber. Various surface treatments, including epoxy coating, mylar membrane covering, and teflon coating, were tested, resulting in up to a tenfold reduction in radon levels. Additionally, a cold trap enrichment method was developed, increasing radon measurement sensitivity by 30 times. A radon removal system with charcoal trap was designed and tested, demonstrating its effectiveness in reducing radon levels within nitrogen and xenon environments. These developments are essential for ensuring minimal radon background in experiments such as PandaX-4T.

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