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Monte Carlo design optimization for the United Kingdom's new neutron monitor, the NM-2023

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This presentation focuses on the extensive Monte Carlo N-Particle (MCNP) simulations used to design and optimize the United Kingdom's (UK) new ground-level neutron monitor, the NM-2023. Through MCNP parameter optimizations and the use of 1-inch diameter, 4-atm helium-3 (He3) gas-filled proportional counters, the monitor achieves a 64% smaller footprint, 80% smaller volume, and 55% of the mass of the 6-NM-64, while delivering equivalent counting performance. The design also allows for potential cost reductions in fabrication and deployment through a simpler slab configuration, reduced volume and cost of raw materials, and smaller housing and infrastructure requirements. The presentation details the derived environmental radiation source, the development of a 6-NM-64 benchmark model, and the creation of parameterized 'cavity'and 'slab'models. The 'cavity'design closely resembles the NM-64, while the 'slab'design is more akin to the IGY monitor. A randomized parameter scan of the 'cavity'model demonstrates that the NM-64 is highly optimized for large-volume boron trifluoride (BF3) counters in terms of lead (Pb) mass relative to total count rate. Parameter optimization of the 'slab'design evaluates configurations based on constant volume, equal Pb thickness, constant Pb mass, and detector placement, resulting in a more compact design with equivalent counting performance to the 4-NM-64. Several experimental campaigns validate the simulation results, providing a robust foundation for the new monitor's design.

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