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Radiation shielding analysis and optimisation for the mineral-PET Kimberlite sorting facility using the Monte Carlo calculation code MCNPX

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Abstract content
   (Max 300 words)

Radiation shielding calculations, analysis and optimization process carried out in order to design shielding for a Mineral-Positron Emission Tomography (mineral-PET) facility are presented. PET is a nuclear imaging technique commonly used in diagnostic medicine. The technique is based on the detection of 511 keV coincident and co-linear photons produced from the annihilation of a positron (produced by a positron emitter) and a nearby electron. This technique is currently being developed for mineral detection and quantification, particularly for diamonds in kimberlite rocks through the Mineral-PET facility. The facility is aimed at improving diamond mining through the early detection of the diamond bearing rocks. High energy photons are produced via bremsstrahlung when high energy, 40 MeV, electrons impinge on a high density target - tungsten. The resultant high energy photon beam irradiates the candidate rock activating the naturally occurring non-positron emitting isotope 12C, and producing a positron emitting isotope 11C via a photo-nuclear (γ, n) reaction. The resultant high intensity and high energy radiation field (which includes both photons and neutrons up to 40 MeV) requires appropriate shielding to protect personnel and the environment around the facility. A Monte Carlo based radiation transport code, MCNPX, was used to model the Mineral-PET facility including the electron accelerator, the irradiation chamber and the proposed shield. The shielding calculations were performed, applying the theory of interaction of radiation with matter together with the modeling and the radiation transport calculation capabilities of MCNPX. The calculations were applied to determine the types, optimum combinations and thickness of shielding materials. About 1.6 m of shielding composed of lead, Iron, Wax and Boron carbide combined in the shield matrix are sufficient to drop dose rates to acceptable levels on the personnel side of the shield, where several meters of concrete would have been required.

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yes

Level for award
 (Hons, MSc,
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MPhil

Main supervisor (name and email)
and his / her institution

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