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## MinPET: Knowledge transfer from particle physics to precious stones

MinPET is an intelligent, sensor-based sorting technology to map light element concentrations inside host rock at run-of-mine throughput. This technique can bring large savings in the monetary and environmental cost of diamond mining. Conventional techniques have poor recovery rates due to occlusion of exposed diamonds and encapsulation within kimberlite. This requires scrupulous washing and multiple stages of crushing to liberate diamonds, using large quantities of water and energy.

In contrast, MinPET aims to image carbon concentrations using Positron Emission Tomography. A high power 40 GeV Linac is used to generate a gamma beam optimised to excite the Giant Dipole Resonance. Natural carbon is transmuted via the reaction  $^{12}\text{C} \rightarrow (\gamma, n) \rightarrow ^{11}\text{C}$ . Background signatures such as  $^{15}\text{O}$  and non carbon origin  $^{11}\text{C}$  are also produced. The decay of shorter lived PET isotopes is awaited before scanning. Large-area planar PET detector arrays record coincident hits. GPU compute is used to reconstruct activity tomograms at high speed. Machine learning is used to develop classifiers that discriminate diamond-bearing rocks. The latency of this data-acquisition - reconstruction - classification pipeline is critical to ensure mechanical separation of concentrate in a reasonable sized installation.

The project has supported 4 PhD students, 2 MSc students and 5 Honours research projects. Geant4 is used for full-fidelity simulation of material activation and detection. There is international collaboration with engineering companies on accelerator conceptual design and sub-scale detector production and characterisation.

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