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Developing a very high-energy electron radiotherapy facility at the ANSTO Australian Synchrotron

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Ultra-high dose-rate, very high-energy electrons (VHEE, electrons with energy greater than 50 MeV) are of increasing interest to the field of radiotherapy, due to their ability to penetrate deeply into tissue and reach tumours that are out of reach to clinical electrons of lower energies. Linacs capable of reaching these energies are also capable of exceedingly high dose-rates, many orders of magnitude above that of the threshold for FLASH radiotherapy (40 Gy/s), an emerging modality praised for its normal tissue sparing qualities.

While ongoing efforts are being made globally to quantify the exact parameters that deliver a FLASH effect, clearly, dosimetry for ultra-high dose-rate environments is required. The Australian Synchrotron's emerging Pulsed Energetic Electrons for Research (PEER) beamline delivers 100 MeV electrons and has been used to investigate the dose-rate (DR) and dose-per-pulse (DPP) independence of the MOSkin detector, a promising candidate for FLASH dosimetry. Previously, DR independence was established and, more recently, DPP independence was investigated. With up to 28 Gy DPP delivered in 200 ns, corresponding to average DRs as high as 1.65×10^8 Gy/s, the MOSkin was shown to remain linear in its response (Figure 1) and is currently the only suitable candidate for on-patient quality assurance dosimetry during FLASH radiotherapy.

With suitable dosimetry established, in-vitro biological investigations have been conducted to investigate cell survival curves at VHEE ultra-high dose-rates and compared to 2 Gy/s, 100 keV synchrotron x-rays, as well as another VHEE facility for the purpose of benchmarking the facility.

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