

# Deep Learning for Enhanced Muon Tomography Imaging

William O'Donnell<sup>1,2</sup>, David Mahon<sup>1,2</sup>, Guangliang Yang<sup>1,2</sup>, and Simon Gardner<sup>1</sup>

<sup>1</sup>The University of Glasgow, Glasgow, UK, <sup>2</sup>Lynkeos Technology Ltd., UK

Across the civil engineering and nuclear industries, there is an increasing need to perform non-destructive testing on assets such as bridge decks and nuclear waste containers. Techniques such as ground penetrating radar and ultrasound are limited in achieving consistent high-resolution imagery across large volumes, and while X-rays overcome this problem, they are often met with concerns over the use of a highly ionizing source. Muography is an emerging non-invasive technique that constructs three-dimensional density maps by detecting the interactions of naturally occurring cosmic-ray muons within the scanned volume. While muons can penetrate deep into structures, their low flux results in long acquisition times for high-resolution imaging. Recent work has demonstrated that machine learning can be applied in post-processing of muographic images to reduce noise and perform detailed segmentations of structural features, when applied to a dataset of simulated concrete data. The ability of machine learning models to produce consistent outputs at lower event counts allow for a significant reduction of imaging time, thus mitigating one of the key drawbacks of the technique.

Ongoing research focuses on validating these simulation-trained models with experimental muography data to assess their robustness in practical scenarios. Furthermore, investigations of model architectures and the format in which data is presented to the model are underway to improve model performance.

This work ultimately aims to enhance the capabilities of muographic imaging, making it more attractive for wide-scale industry adoption.