Study of modulation properties of tungsten based coded-aperture

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The application of coded-aperture techniques for radiation imaging systems can be seen in various application fields, but the use of coded-apertures in mixed-field radiation detection in nuclear decommissioning remains largely unexplored. It is a key to understand the gamma-ray modulation properties of a tungsten based coded aperture, in order to explore the suitability of coded-apertures for mixed-field radiation detection systems. In this paper, an investigation into the gamma-ray modulation properties of a tungsten coded aperture is presented. The aperture was designed using the mathematical principles of Modified Uniformly Redundant Arrays (MURA). Due to the complexity of the design and the small size of individual cells, the aperture was built using additive manufacturing methods. The gamma-ray field was produced by ^{137}Cs radioactive isotope at Lancaster University, UK. An organic plastic scintillator sample, which is capable of pulse shape discrimination, has been used to detect the gamma-ray field modulated by the tungsten aperture. The scintillator was energy calibrated using ^{137}Cs and ^{22}Na sources, before the first measurements of the modulated gamma-ray field were taken. The pulse shape discrimination performance of the scintillator was subsequently examined, using the mixed-field provided by ^{252}Cf. In this study, each of 169 coded aperture cells were investigated by collimating the modulated gamma-ray field of ^{137}Cs through a 25.4 mm thick lead supporting plate. The supporting plate has a single opening in the centre of the same dimensions as the single aperture cell 2.5 mm x 2.5 mm. The number of pulses detected for every aperture location were recorded in an array. The array was then used to create a two-dimensional image of the source, which was encoded through the coded aperture pattern. Finally, the image was decoded using deconvolution techniques to reveal the actual source location. Results obtained in the study indicate sufficient gamma-ray modulation properties of the aperture, despite the relatively small footprint and thickness of the coded aperture.