

Hybrid Imaging Method Combining Coded Aperture and Compton Imaging for Uranium Holdup Quantification

Nuclear Science & Security Consortium

Goals and Objectives

- Gamma imaging is used to provide improved quantitative estimations of uranium holdup in process equipment when compared to standard holdup methods, mainly the generalized geometry holdup method, which can have uncertainties as high as 50%
- As part of this quantitative holdup work, ORNL needs a software framework to create Compton scatter imaging techniques to combine with ORNL's coded aperture imaging simultaneously from data acquired by the PHDs Germanium Gamma Imager (GeGI)

Introduction

- Coded Aperture Imaging Utilizes lower energy gammas interacting once in the detector through photoelectric absorption
- Image produced from deconvolution from a shadow projected on the detector created from an overlaid mask of a known pattern
- Shadow is dependent on source location within the detector's field of view







Compton Imaging

- Utilizes higher energy gammas interacting multiple times in the detector from Compton scattering followed by photoelectric absorption
- From at least two interactions, the scattering angle can be evaluated, projecting a cone out of the detector at this angle along the interaction axis
- Quantification
- ORNL algorithm uses spectroscopic data in image pixels to determine uranium thickness, enrichment, and mass
- Differential Evolution Adaptive Metropolis (DREAM), a Markov Chain Monte-Carlo transport method





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Detector Setup









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Methodology



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