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Provably Unclassified Radioisotope Algorithm

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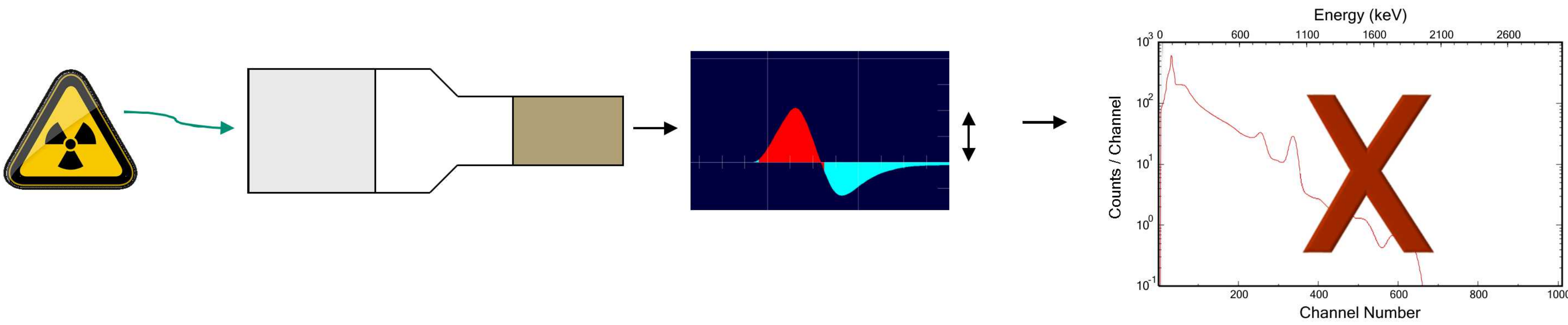
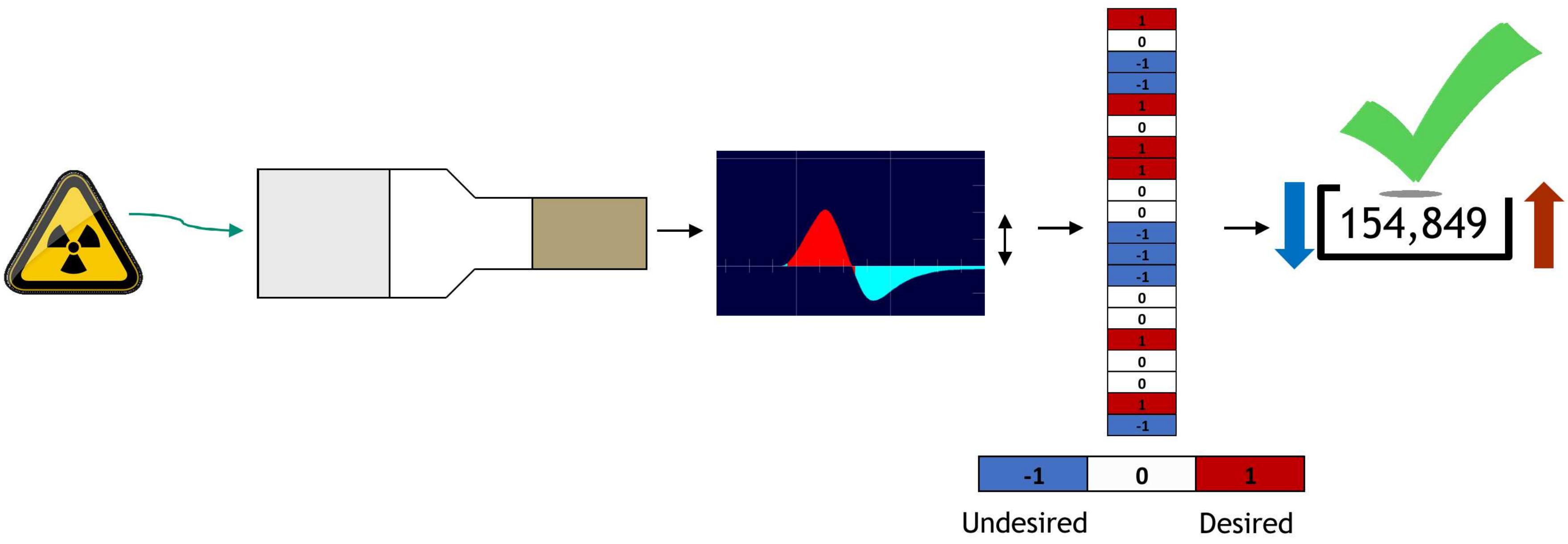
Motivation

- Past nuclear arms control treaties have used some measurements for verification, but future treaties might rely more heavily on tailored verification technologies to ensure compliance
  - Radiation Detection (gamma/neutron)
  - Imaging (passive or radiography)
  - Assay
  - National Technical Means (overhead imagery)
- The nature of this work requires that these technologies be adapted to protect sensitive information from the host perspective, while giving the inspector confidence that the item being monitored is (or is not), in fact, a nuclear weapon
  - Authentication for Inspectors (confidence in the measurement)
  - Certification for Host (information security)
- This regime for arms control has led to the development of novel applications of technology as well as methods for information protection and system authentication and certification

Concept: Provably Unclassified Radioisotope Algorithm (PURA)

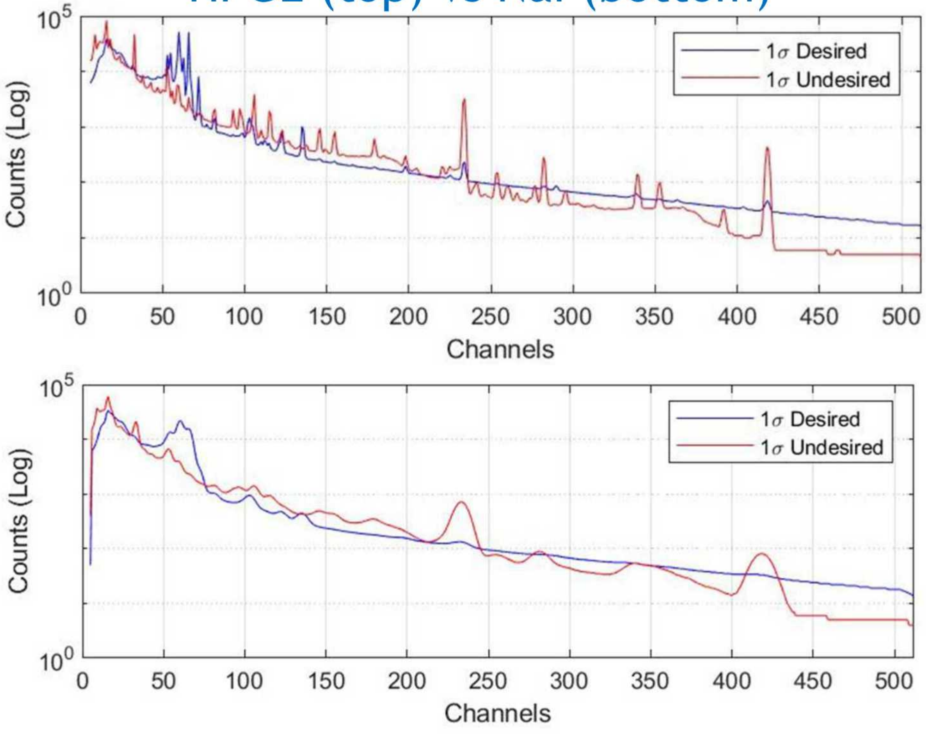




Concept: Provably Unclassified Radioisotope Algorithm (PURA)

- To determine if the object being measured is consistent with a warhead or warhead component (desired), the measured spectra is compared against undesirable radioisotopes that could be substituted.
- This is done by constructing an importance weighted array and binning each individual photon count in list mode.
- This rolling calculation ensures that a spectrum is never collected.

HPGE (top) vs NaI (bottom)

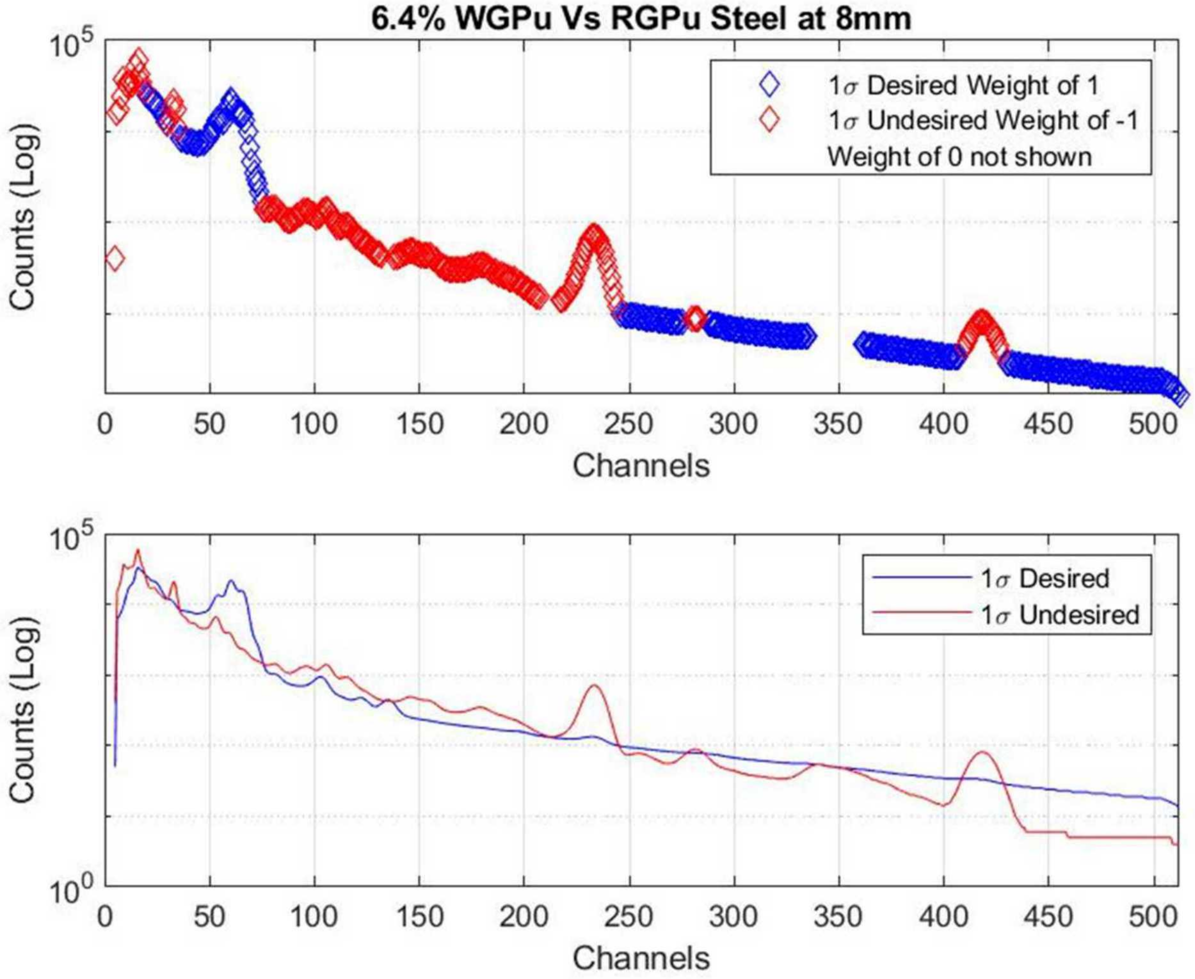


PURA – Assumptions and Limitations

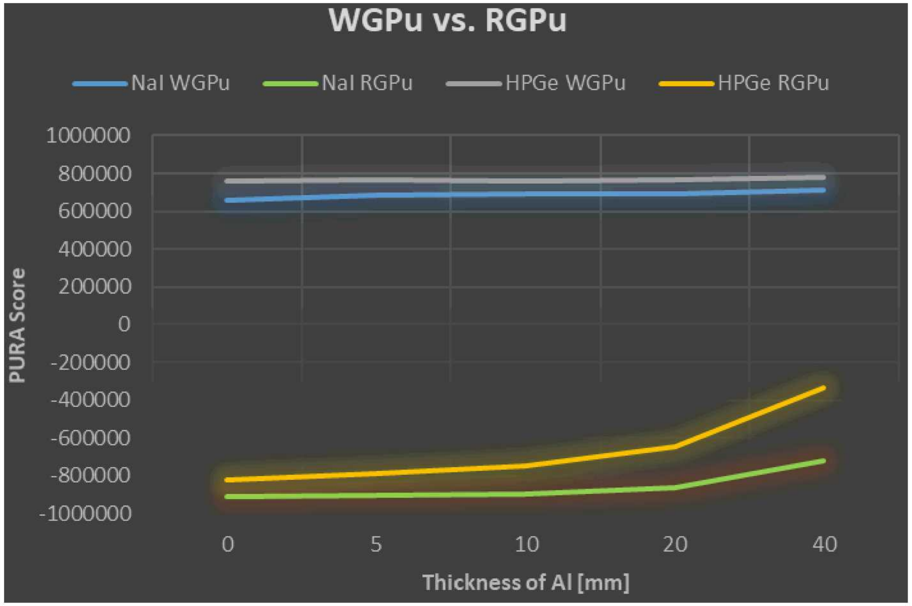
- Requires detector to be in calibration
- Requires strong source relative to background
- Assumes an exhaustive list of non-desired sources
- Desired spectrum/weight array may be sensitive
- Spectra must be normalized to total number of counts; depending on source strength, actual collection time will vary
- So far, testing has been performed using simulated spectra generated by GADRAS

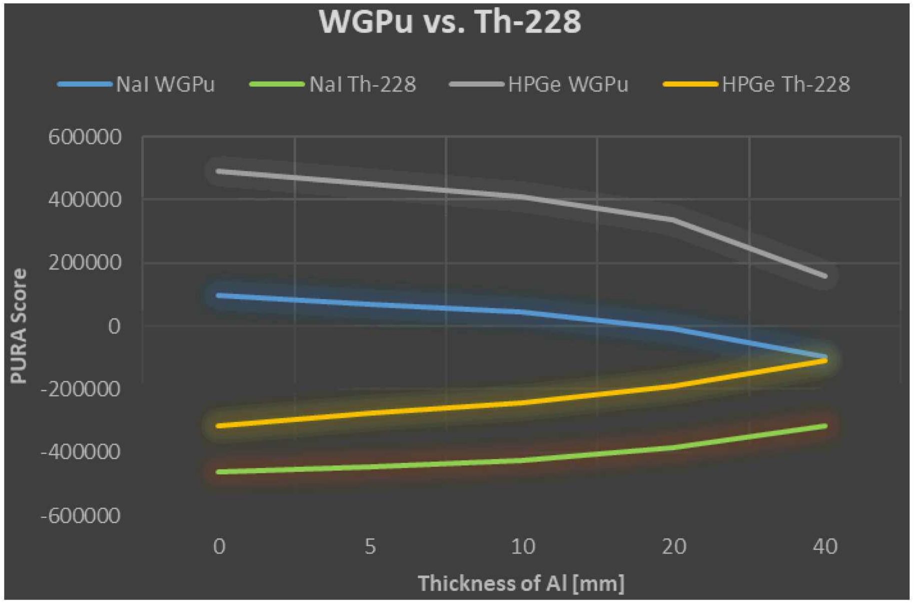
PURA – Implementation

- An automated routine was developed to automatically assign weight arrays based on spectral pair differences
- Performance was tested for HPGe vs. NaI detectors

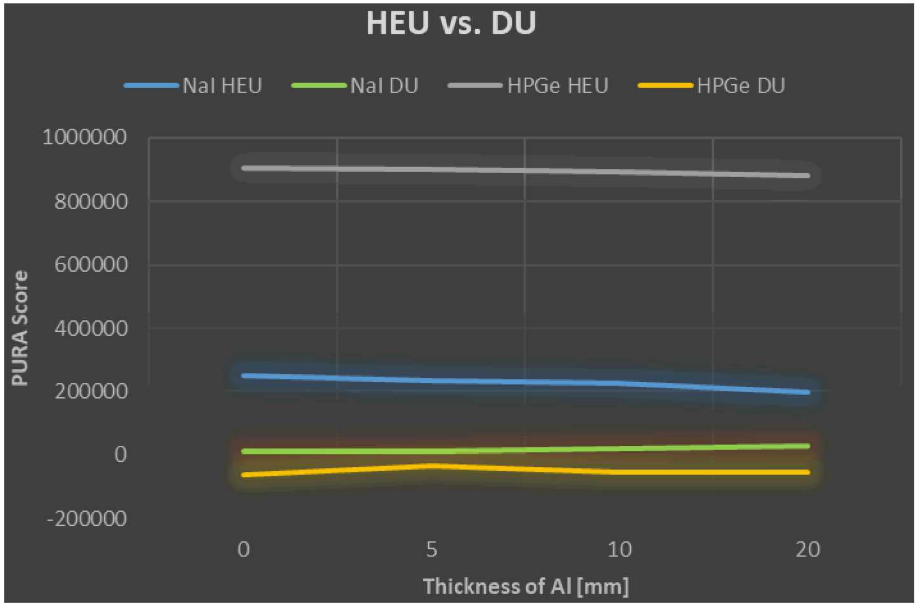


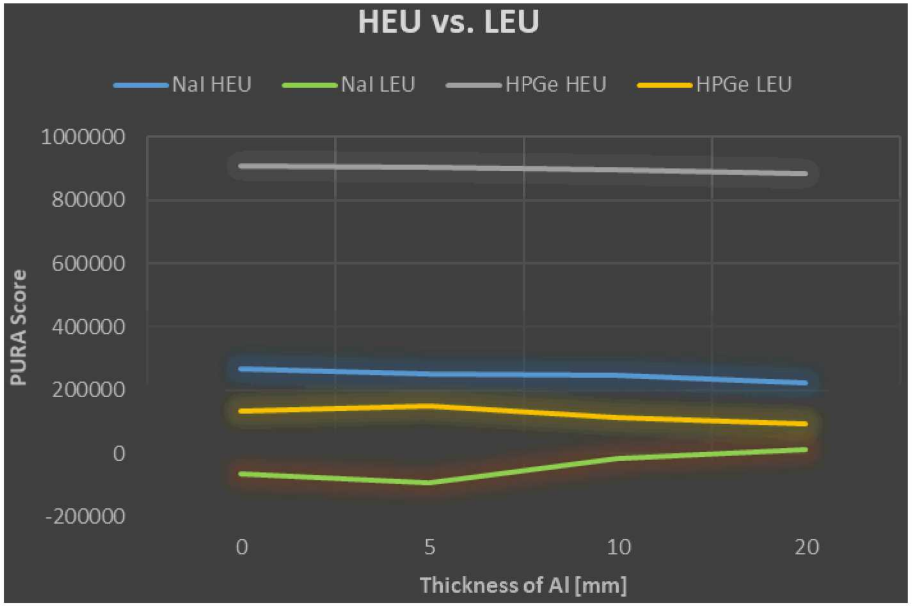
PURA – WGPu Results

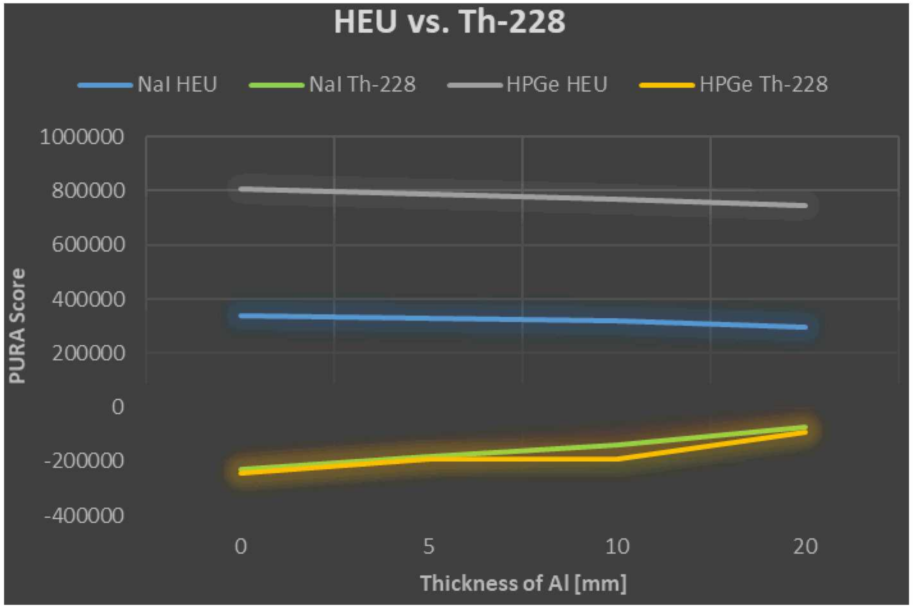


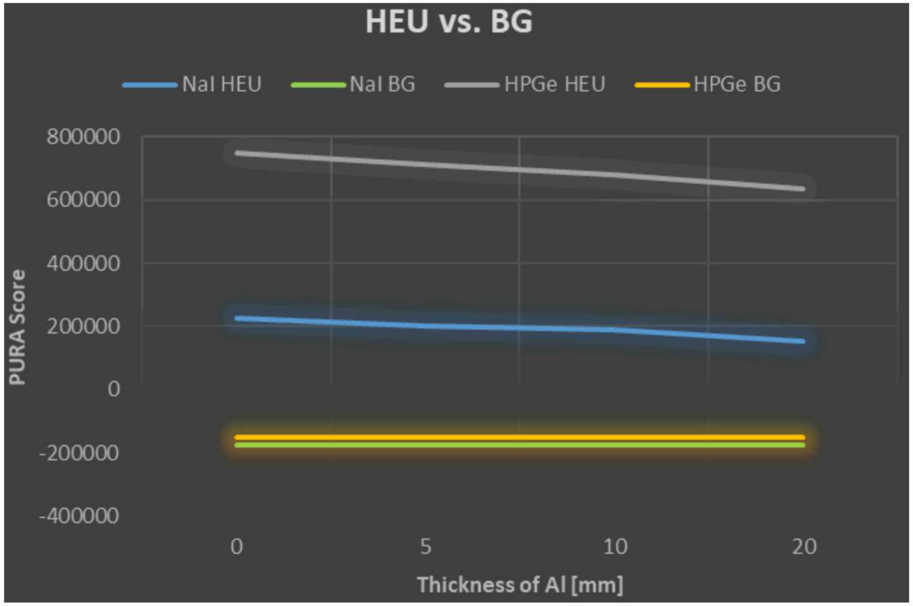


PURA – HEU Results







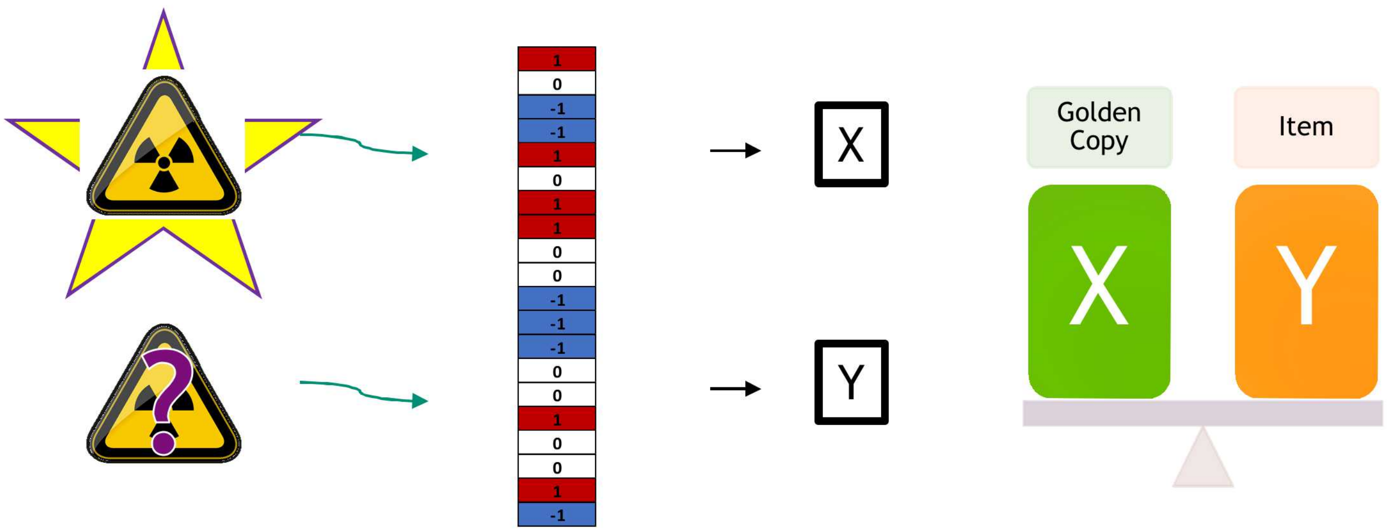


PURA – Future Work

- Exploring effects of automated weight generation parameters (standard deviations)
- Impact of detector resolution on performance of PURA
- Collapsing weight arrays

New Concept: Randomized Verification (RaVen)

- PURA requires some level of a priori knowledge of a source term
- If we have "Golden Copy" we could generate random weight arrays on site
  - Not known before, could not be easily spoofed
  - Lessens importance of detector response function and calibration
- Compare subsequent treaty accountable items to scalar value produced from Golden Copy



Acknowledgements and Questions

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- Gene Kallenbach, Retired