Radionuclide Information Barriers using Novel Statistical Approaches

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Requirements under the Comprehensive Test Ban Treaty

- CTBT requires signatories to permit on-site inspections (OSIs)
- Measurement of the presence of "relevant" radionuclides
- Prevent access to "non-relevant" nuclides
- Detector selection determined by treaties

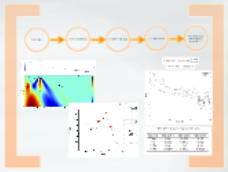
Ideal Solution: Red light/green light

Role of Isotope Identification

- Accurate, automated identifications can allow for the red light/green light indication
- Can eliminate the need for part or all of the spectrum to be viewed
- Can be customized to the specific treaty obligations

How Isotope ID is Currently Done

- Library look up
- Region of interest
- Template matching
- Peak detection



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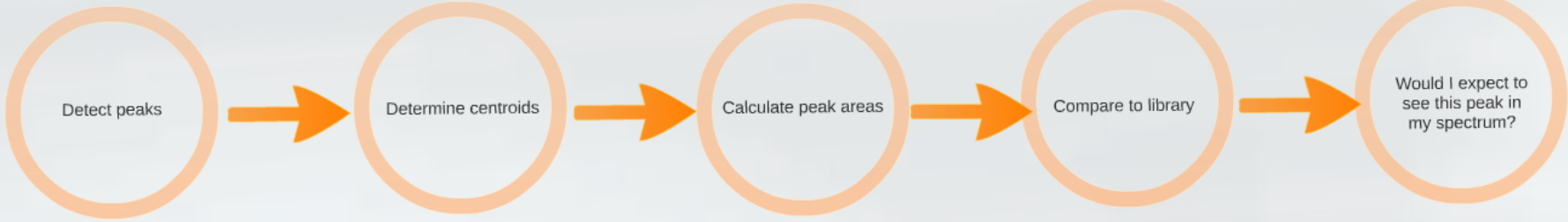
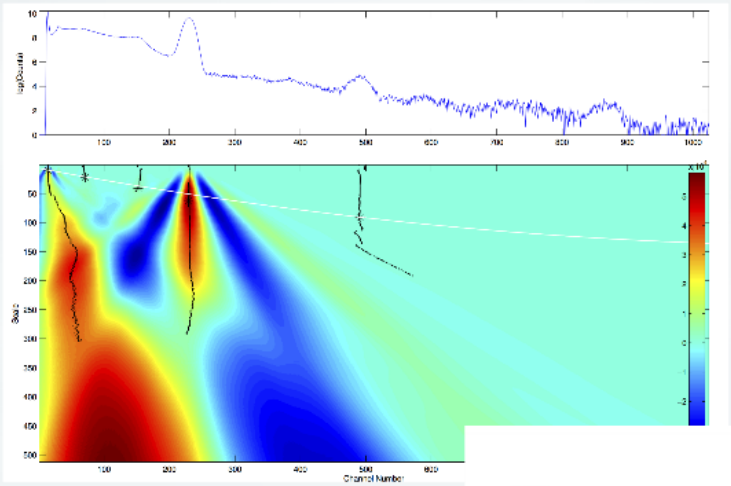
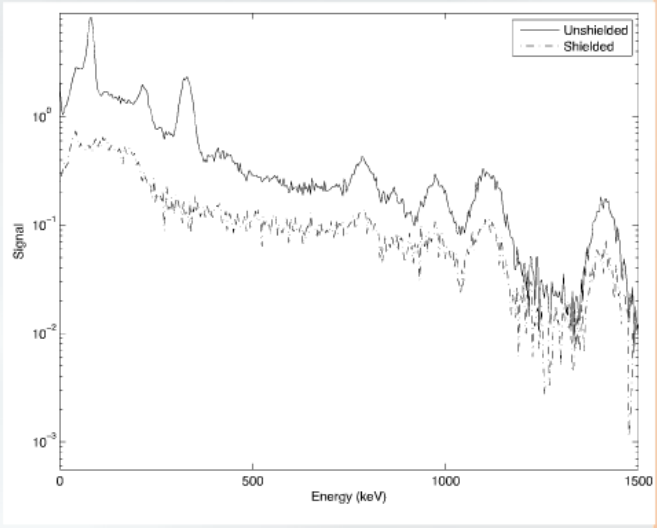
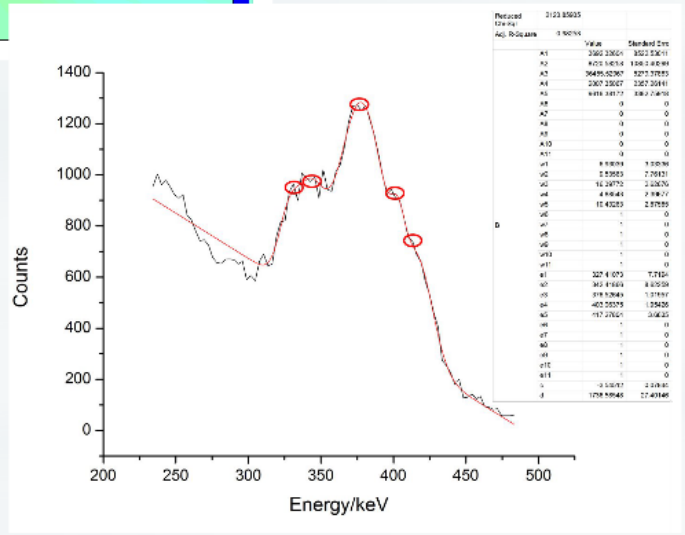




$$P(iso_i|data) = P(data|iso_i)\frac{P(iso_i)}{P(data)}$$

$$P(data|iso_i) = f_{PI}f_{PP}f_{AR}$$





^{152}Eu with 2.1cm lead shielding

Isotope	Method 1	Method 2	Method 3
^{99}Mo	0.31	0.012	0.15
^{123}I	0.062	3.9E-4	0.082
^{152}Eu	0.61	.98	0.84
^{239}Pu	0.0075	1.7E-4	0.0026

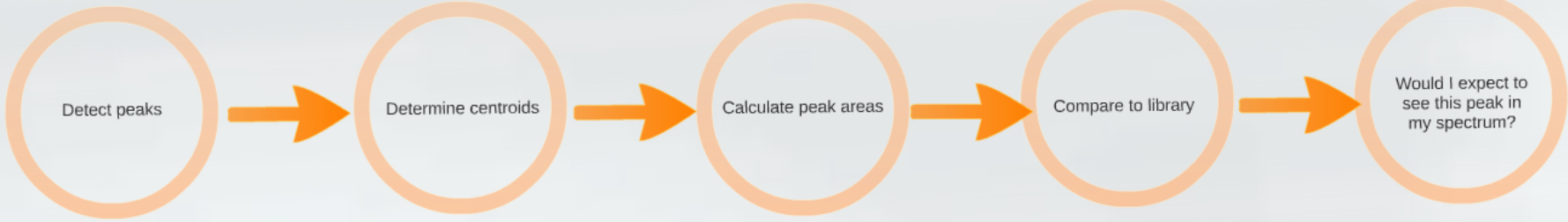
Detect peaks

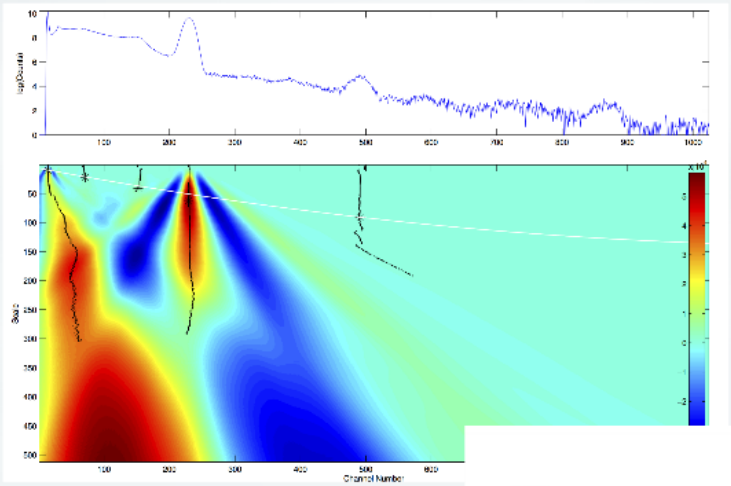
Determine centroids

Calculate peak areas

Compare to library

Would I expect to see this peak in my spectrum?





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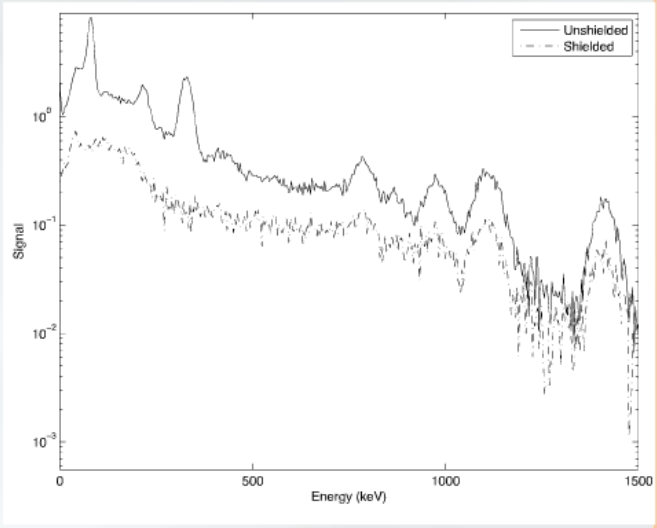

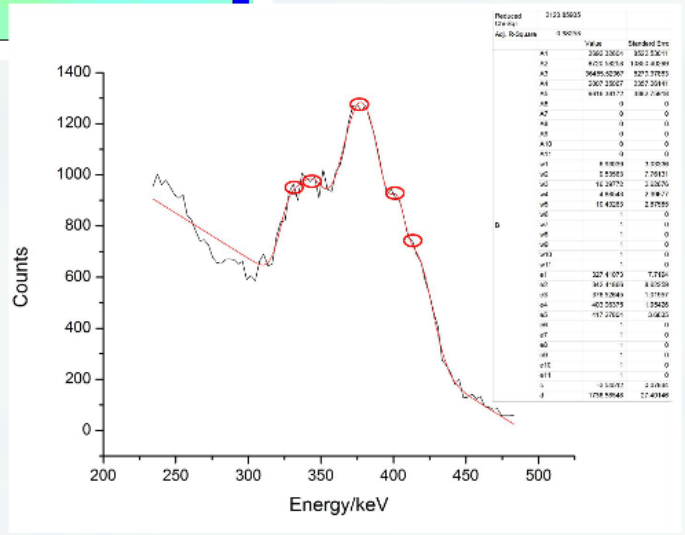

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Our Proposed Research

- Measure the impact of detector response function (i.e. optimal scale curve) on peak quantification
- Expand wavelet and library algorithms to include a broad range of detectors
- Evaluate treaty-specific "relevant" isotopes
- Quantify appropriate information barriers based on developed algorithms

Other Potential Contributions by UIUC

- PI has extensive experience working with the nuclear materials and facility requirements of the DAF and NTS
- PI has direct access to many IAEA inspectors engaged in these measurements today
- Facilities, comms, and accesses at UIUC
- **IRRMA-X, Chicago, 2017**

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