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Title: Developments in the Microcalorimetry Program at Los Alamos National Lab

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Developments in the Microcalorimetry Program at Los Alamos National Lab

Jacob Ward

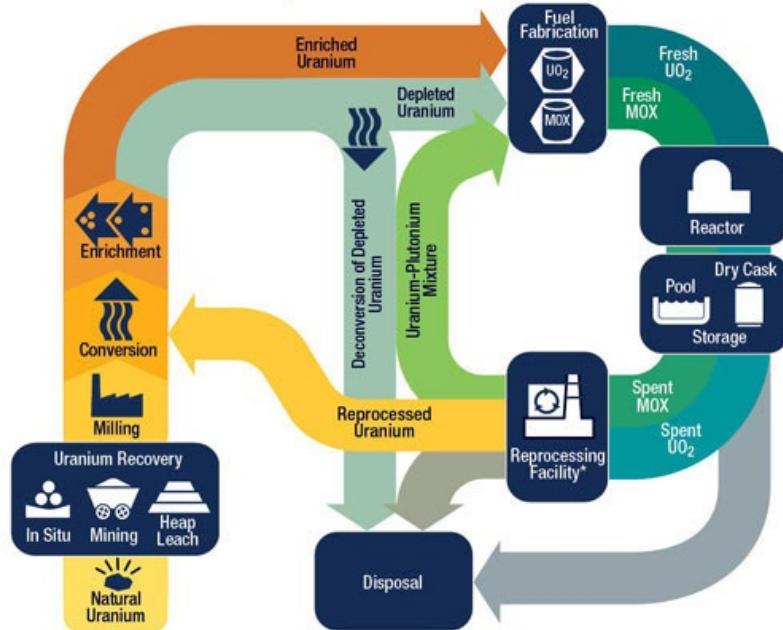
NEN-1, Safeguards Science and Technology

November 3rd, 2023

LA-UR-23-XXXXX

Nuclear Safeguards

The Nuclear Fuel Cycle



* Reprocessing of spent nuclear fuel, including mixed-oxide (MOX) fuel, is not practiced in the United States.
Note: The NRC has no regulatory role in mining uranium.

As of January 2019



Inspectors collect environmental samples

Analysis at the environmental sample laboratories

Confirm completeness of State Declarations

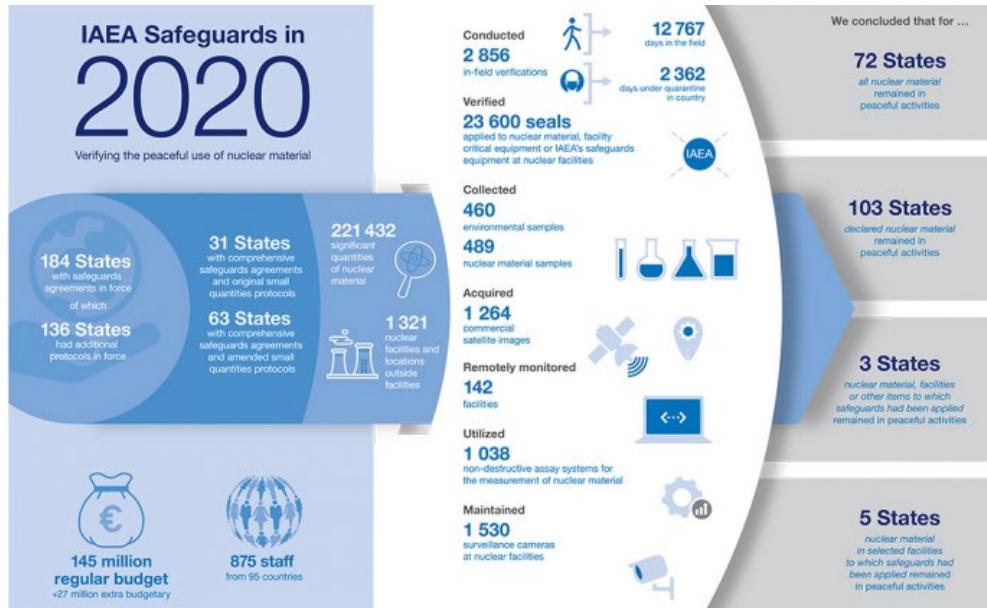
Inspectors collect nuclear material samples

Analysis at the nuclear material laboratories

Confirm correctness of State Declarations



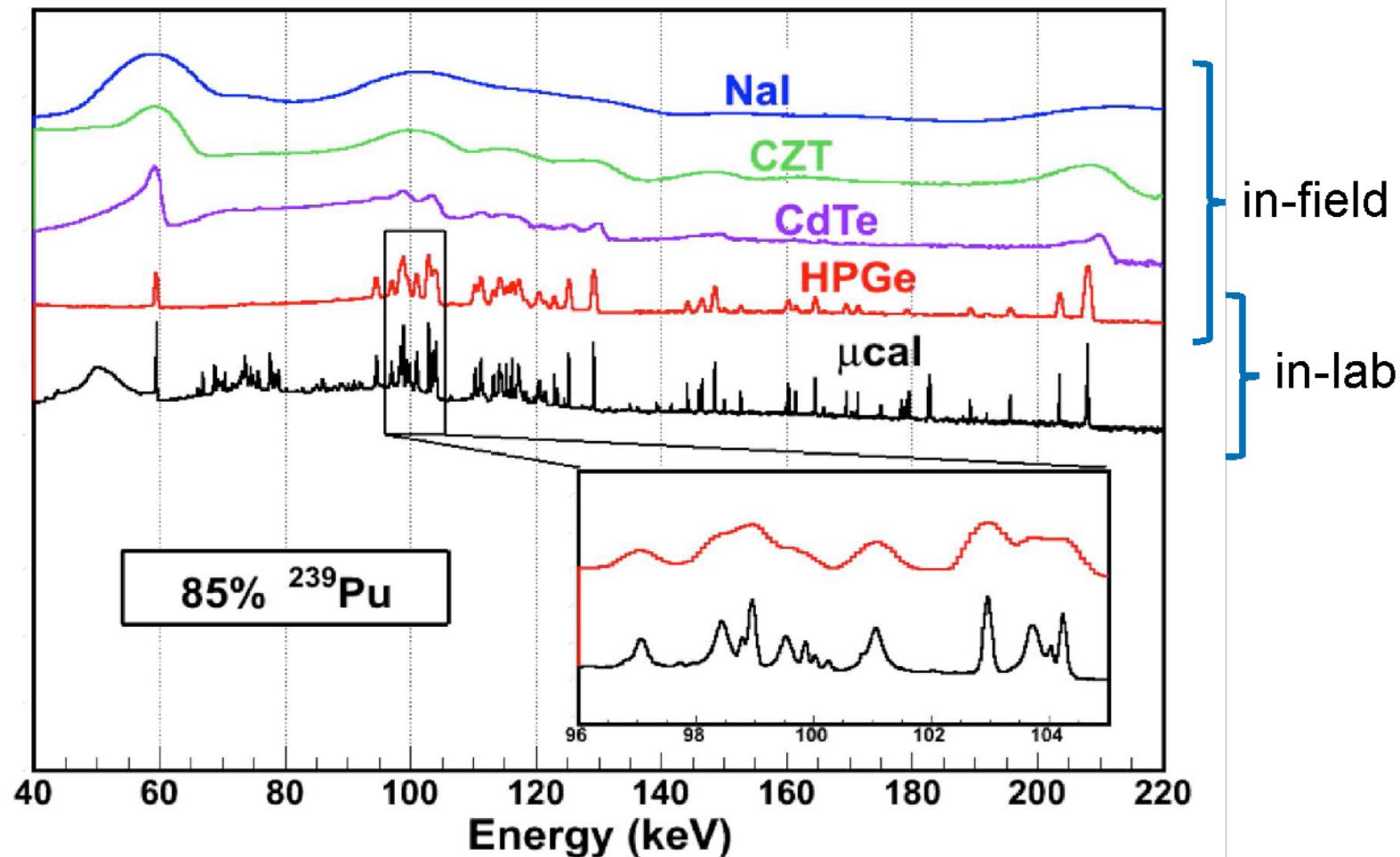
Nuclear Safeguards



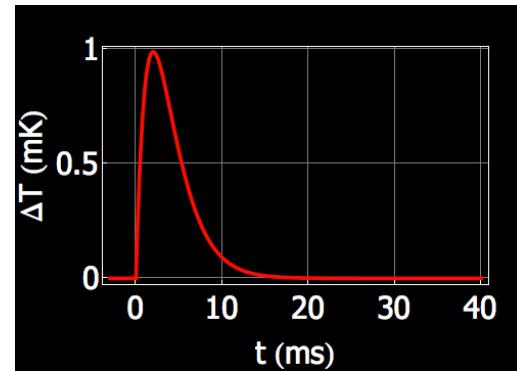
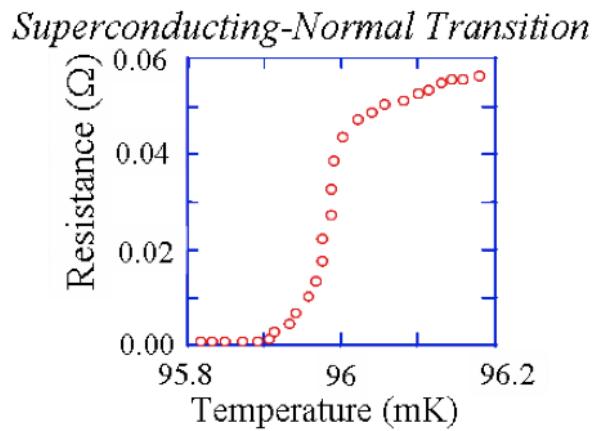
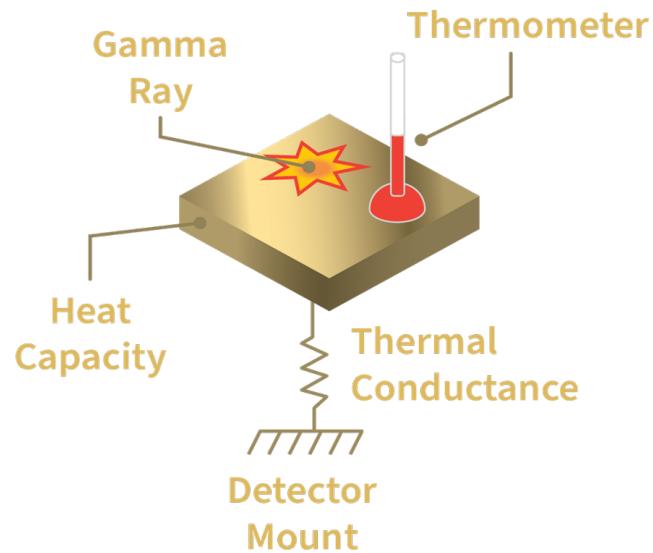
Nuclear Safeguards Tools



Nuclear Safeguards R&D Developments: Low Temperature Detectors

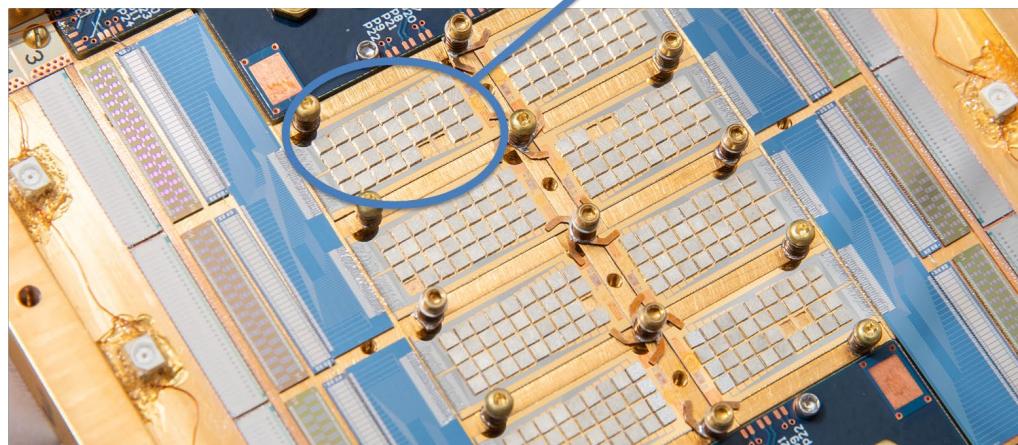
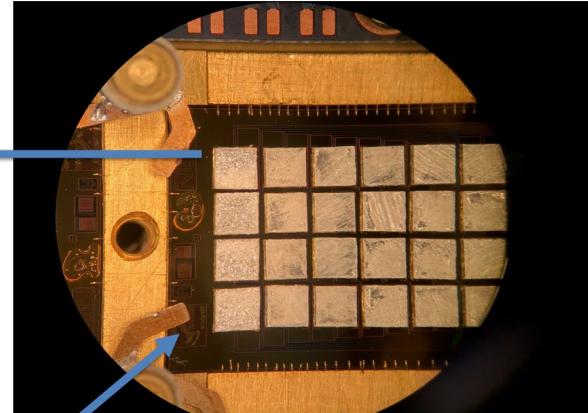
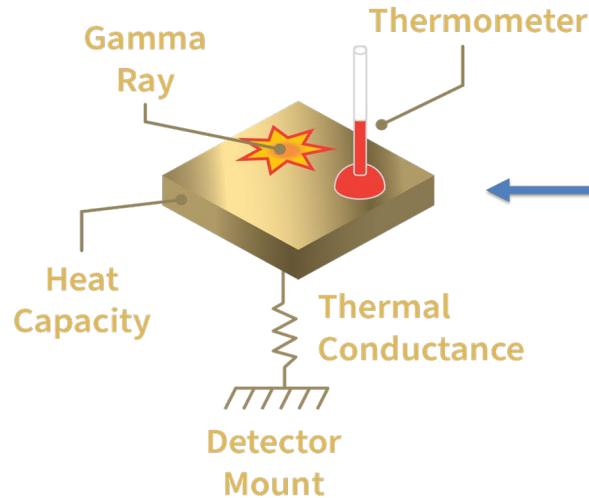


Transition Edge Sensors (TES)

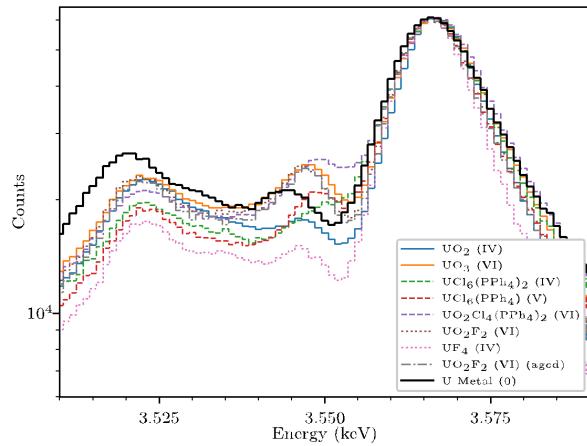


$$E = C \times \Delta T \quad \Delta E \approx \sqrt{4kT^2C}$$

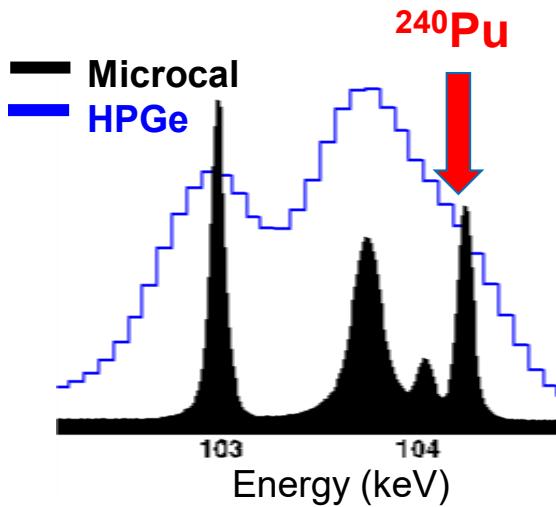
Microcalorimeters



Microcalorimeters

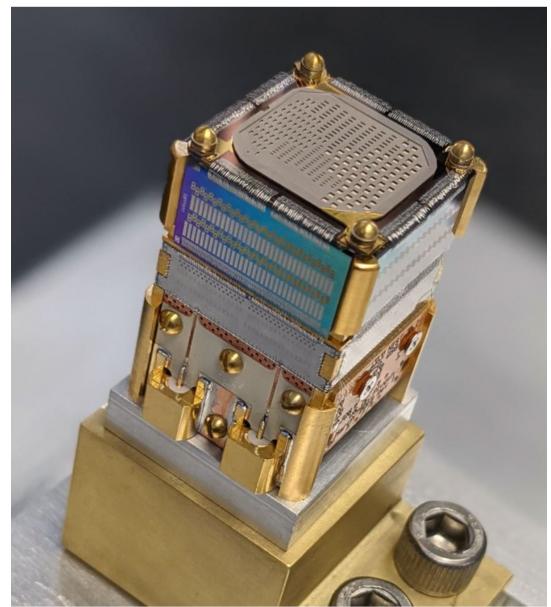
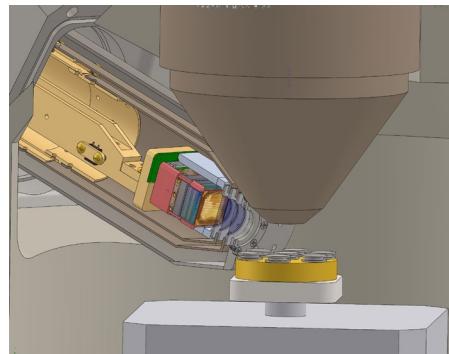
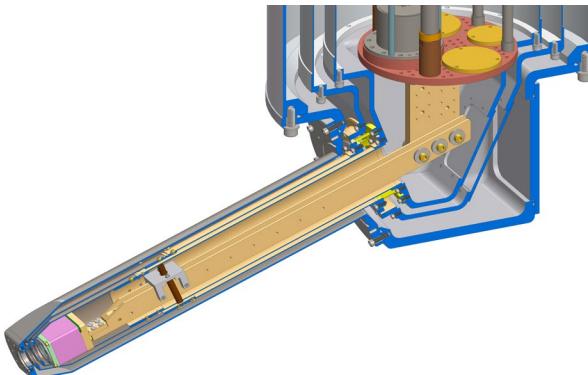


X-ray spectroscopy

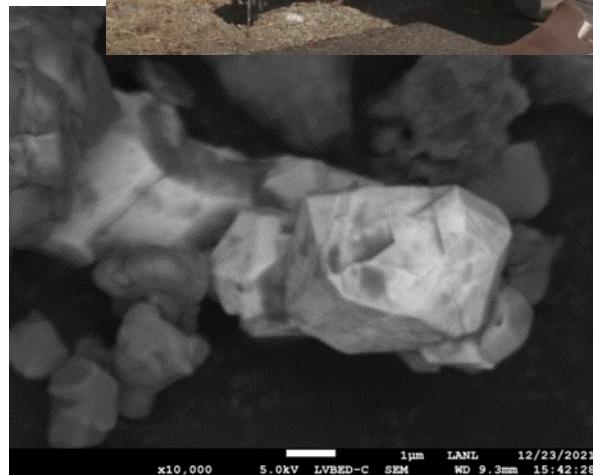
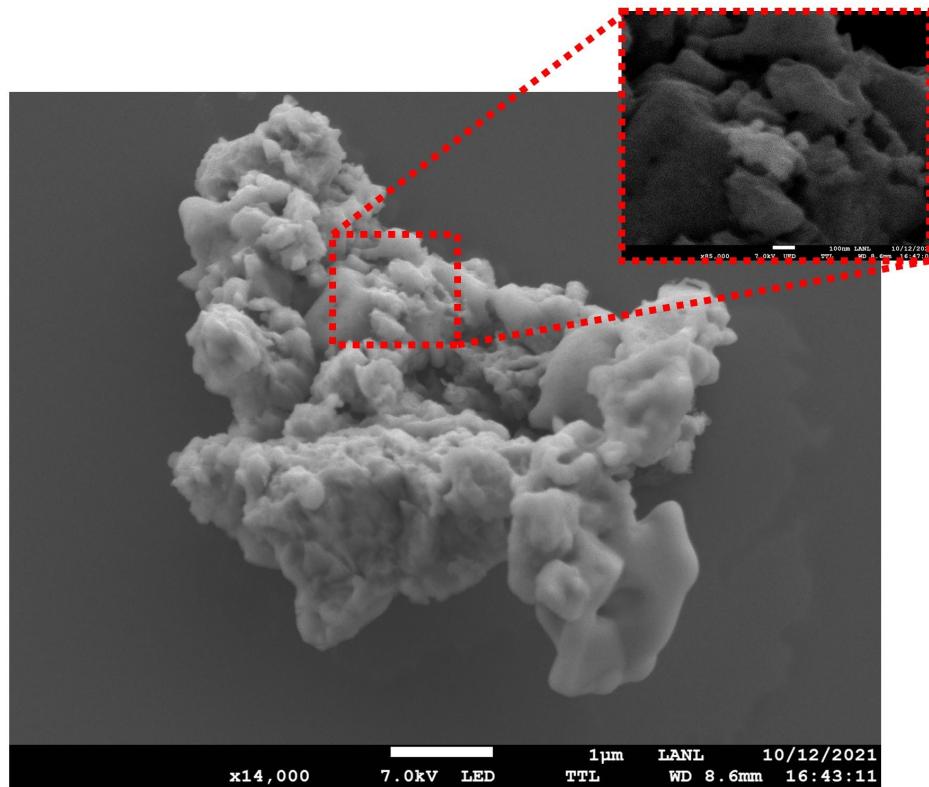


*Gamma-ray
spectroscopy*

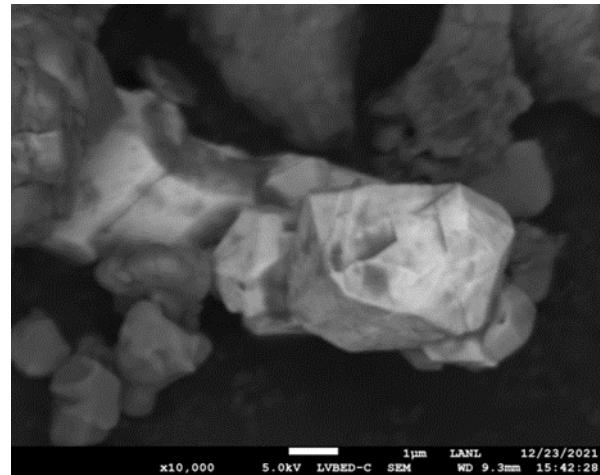
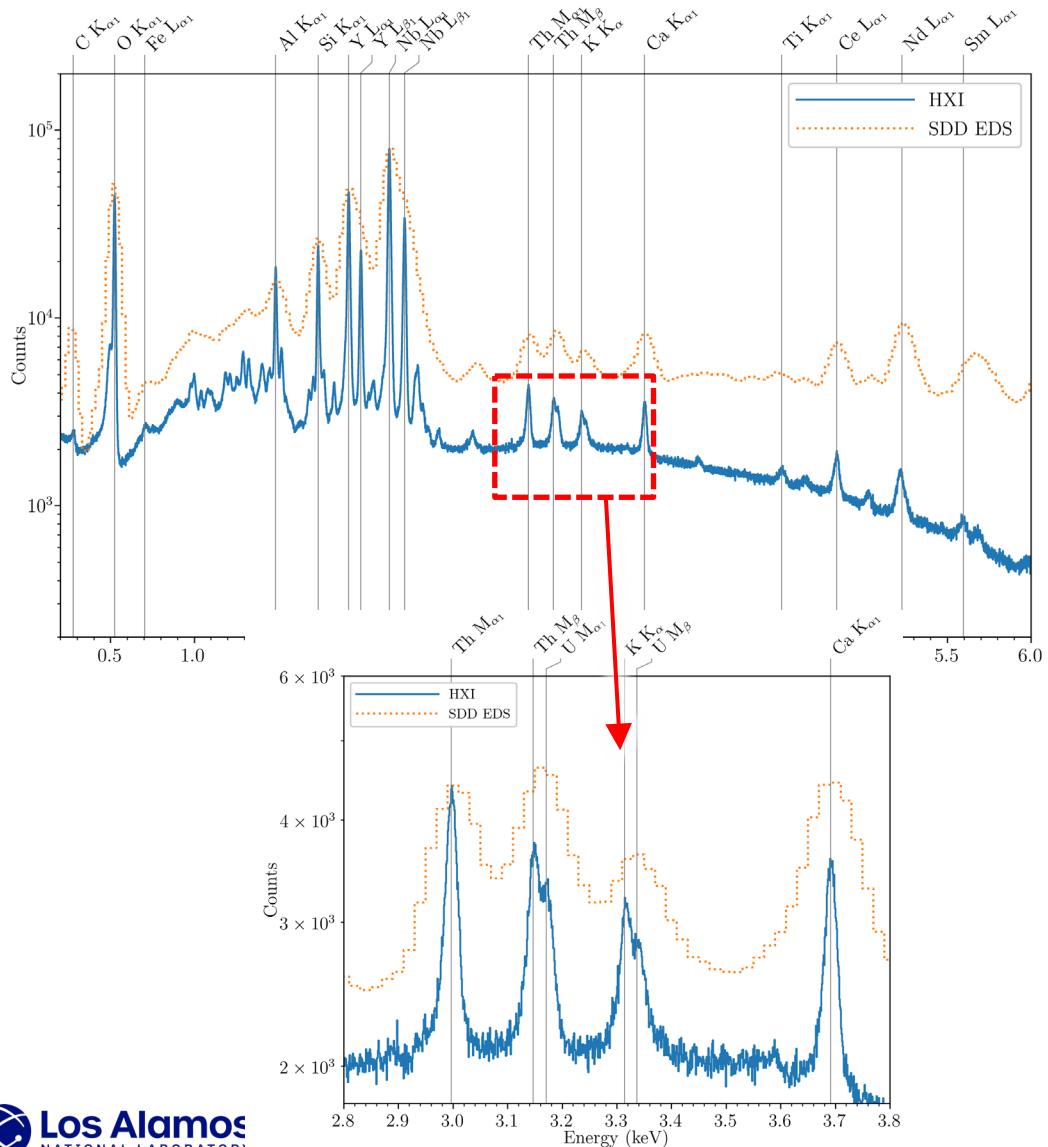
Hyperspectral X-ray Imaging (HXI)



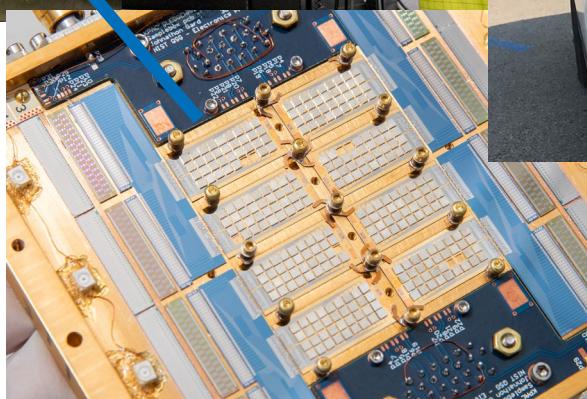
Hyperspectral X-ray Imaging (HXI)



Hyperspectral X-ray Imaging (HXI)

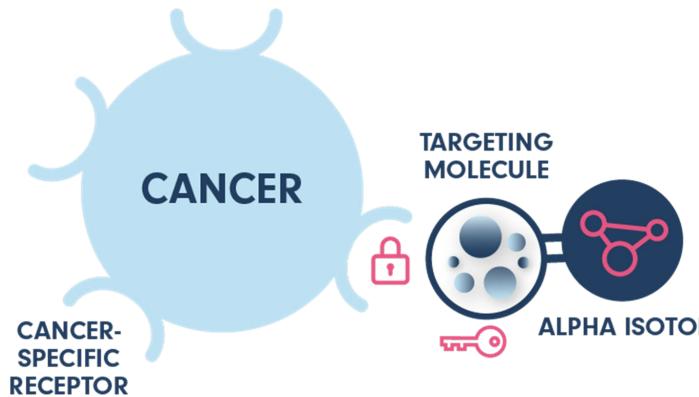


Spectrometer Optimized for Facility Integrated Applications (SOFIA)



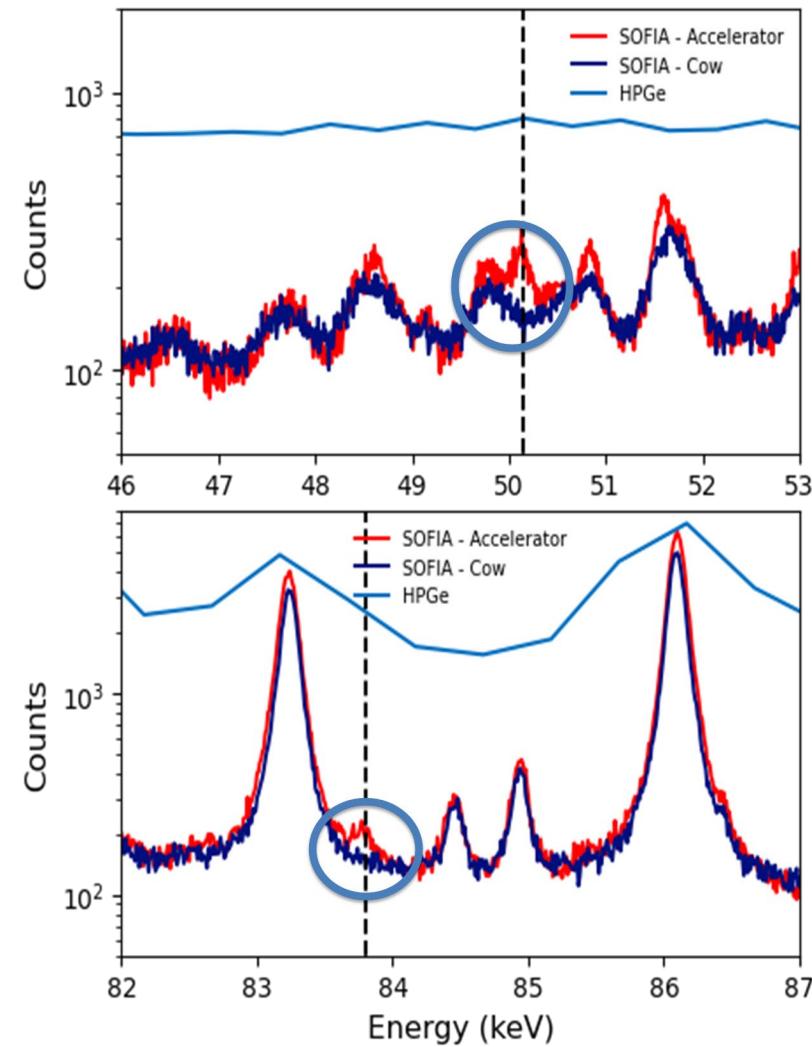
S O F I A
Spectrometer Optimized for Facility Integrated Applications

Targeted Alpha Therapy Using Actinium 225 Measured with SOFIA

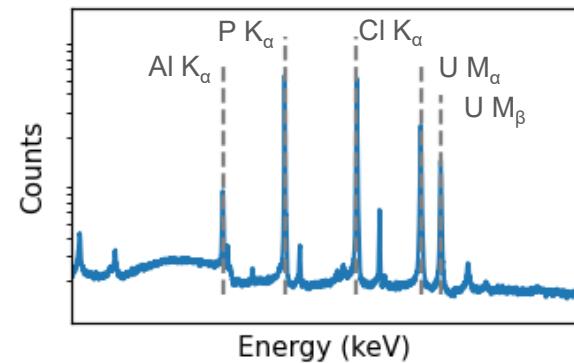
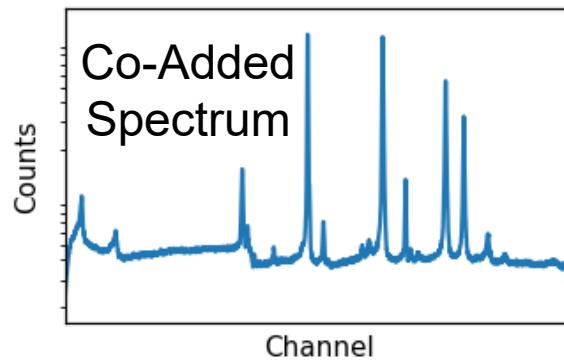
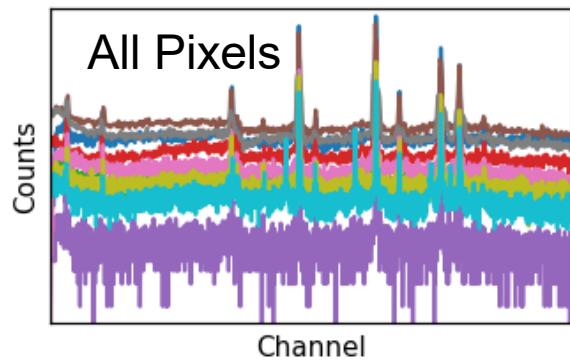
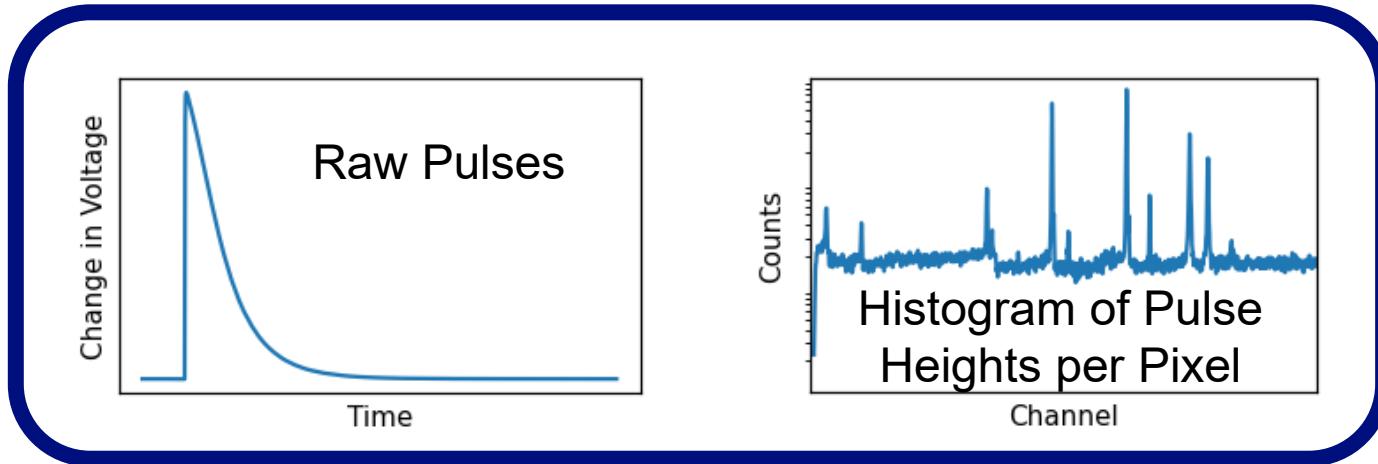


		U-232	U-233	U-234	U-235	U-236
		68.9 years	1.592E5 years	0.0054 2.455E5 years	0.0724 7.04E8 years	2.342E7 years
	Pa-230	17.4 days	Pa-231	Pa-232	Pa-233	Pa-234
		3.276E4 years	100 days	1.32 days	26.975 days	6.70 hours
	Th-228	Th-229	Th-230			
	1.9116 years	7920 years	7.54E4 years			
Ac-225	Ac-226	Ac-227	Ac-228			
10.0 days	1.224 days	21.772 years	6.15 hours			
Ra-224	Ra-225	Ra-226				
3.66 days	14.9 days	1600 years				

Legend: β^- (green), α (orange), γ (grey).

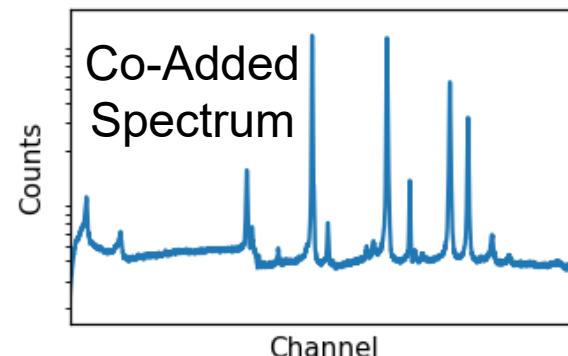
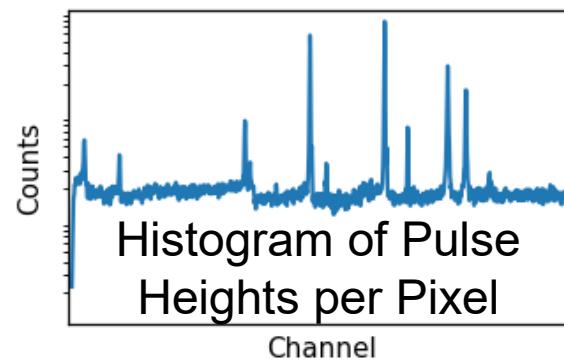
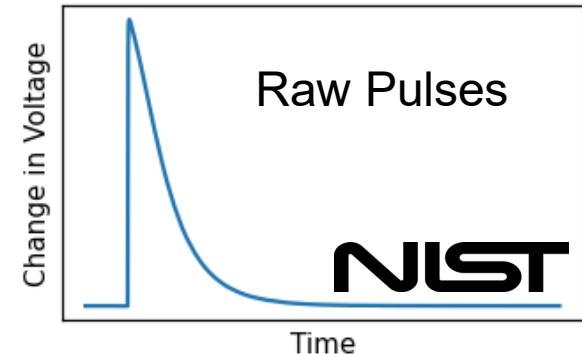


Raw Data to Spectrum

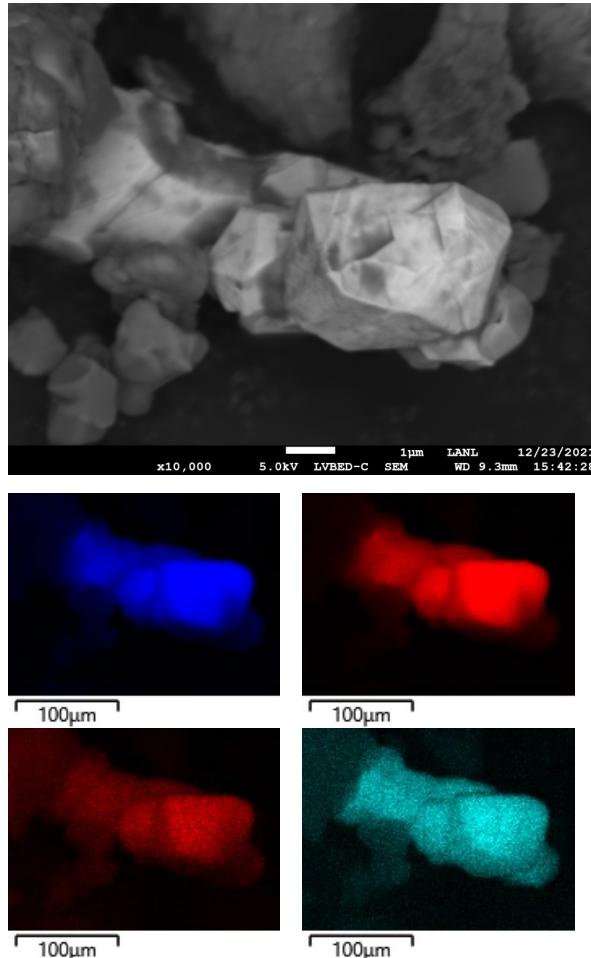


Energy-Calibrated
Spectrum

MicroMatcher

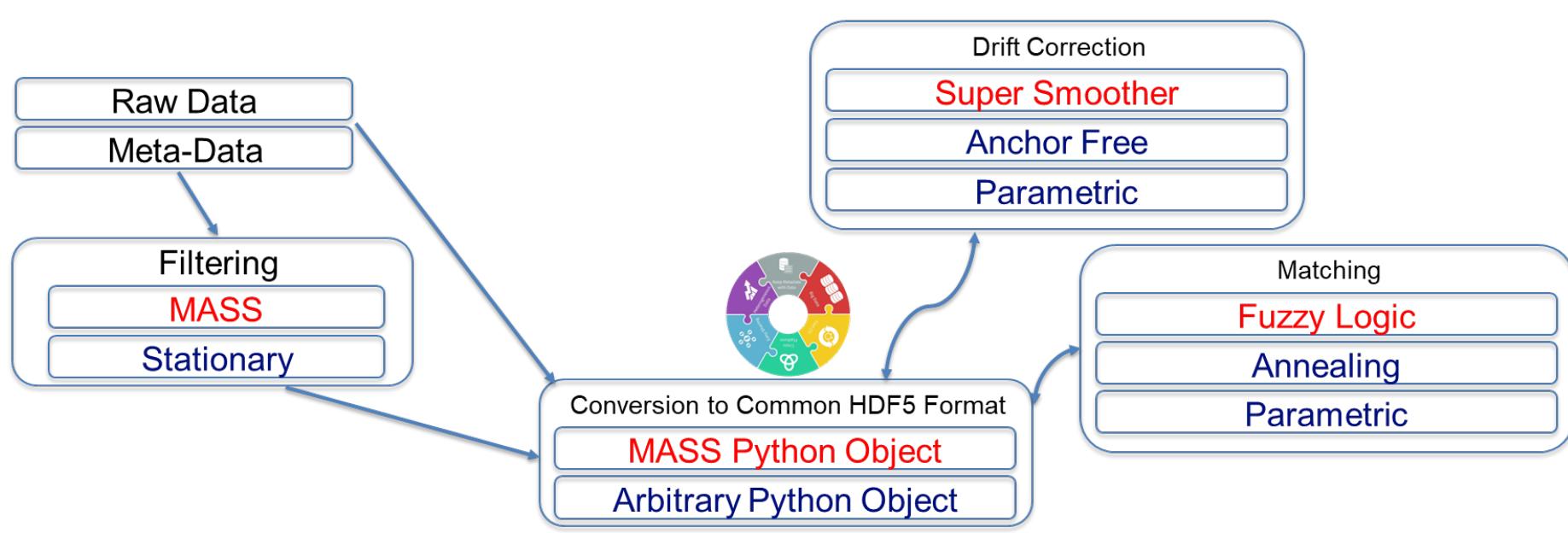


Next Generation Applications: Spatial Mapping

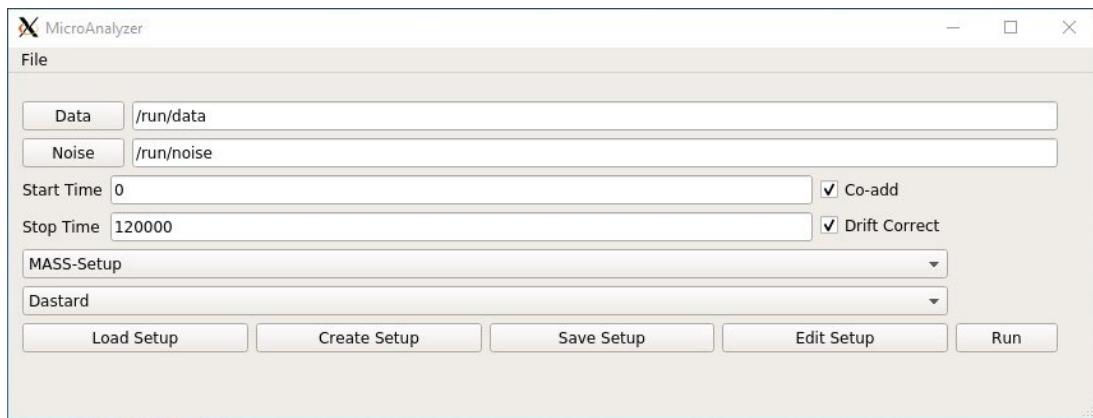


MicroAnalyzer

MicroAnalyzer

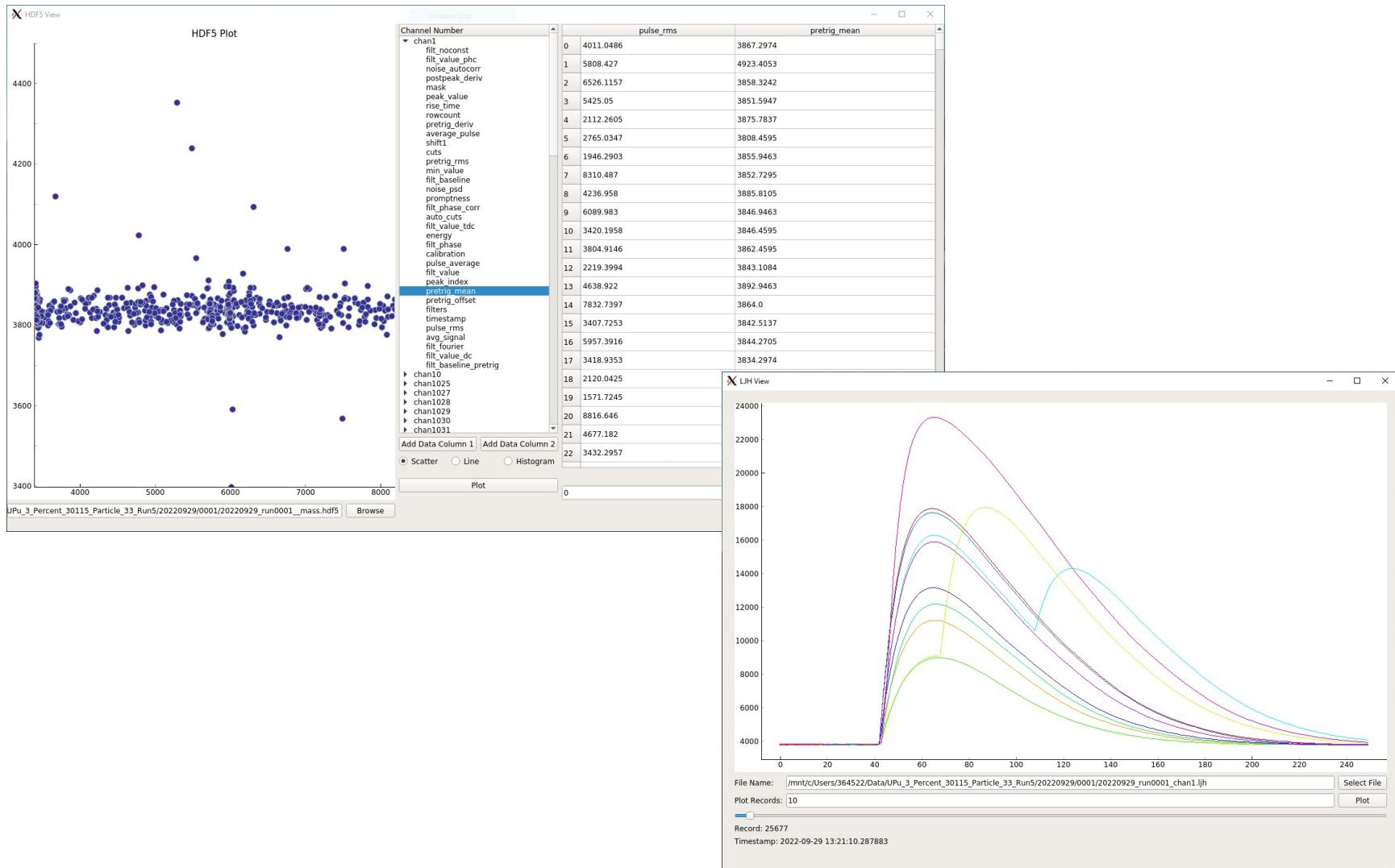


MicroAnalyzer UI

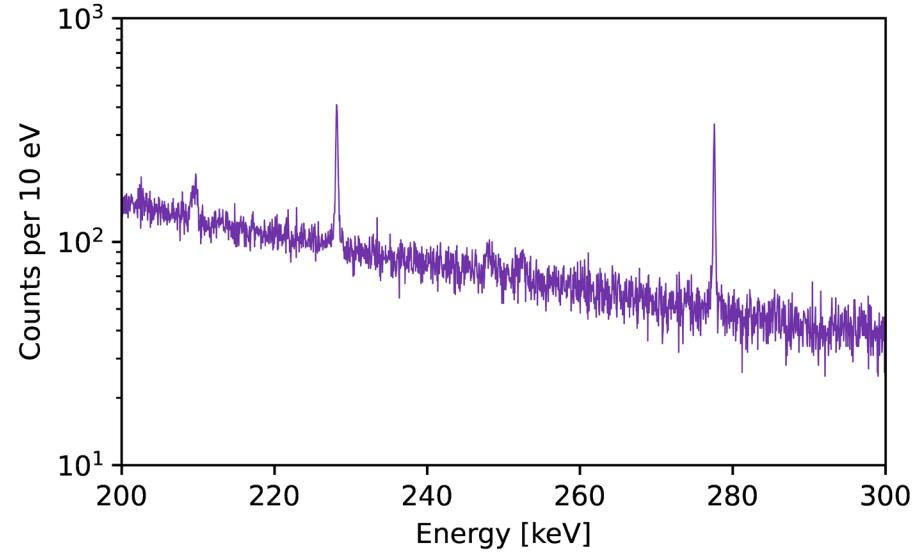
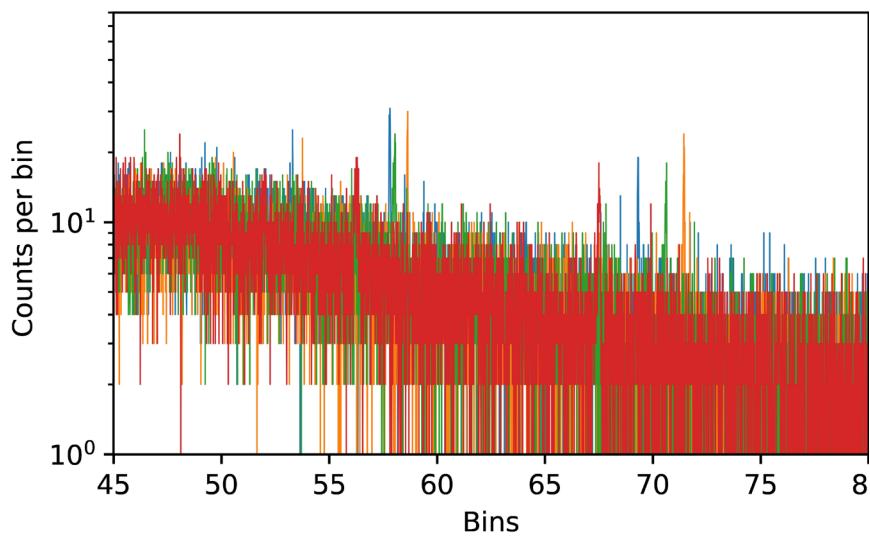
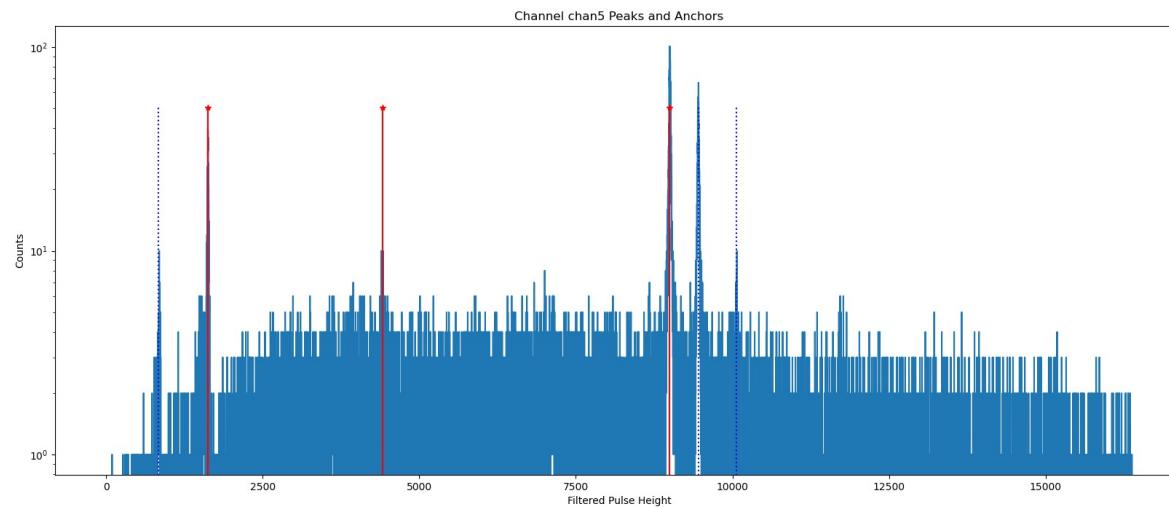


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2 noiseDir	/mnt/c
3 iType	
4 dType	Dastard-Dete...
5 nSets	1
6 setNames	[""]
7 _sets	[]
8 pretriggerign...	25.0
9 startTime	0
10 endTime	-1
11 autoCuts	True
12 timeStampCuts	True
13 peakTimeCuts	True
14 universalCuts	True
15 FWHMEstimate	20.0
16 gain	1.0
17 minPeakToB...	2.0

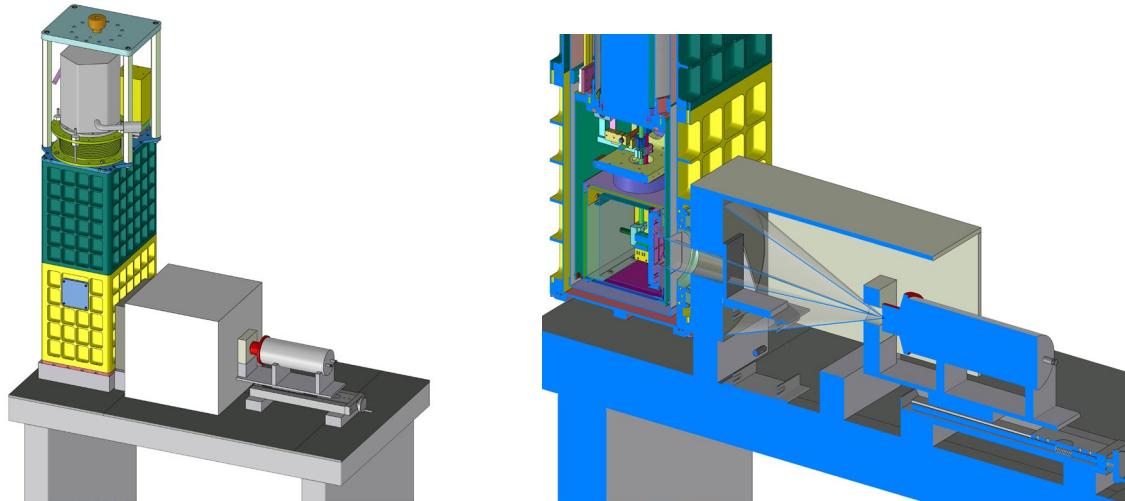
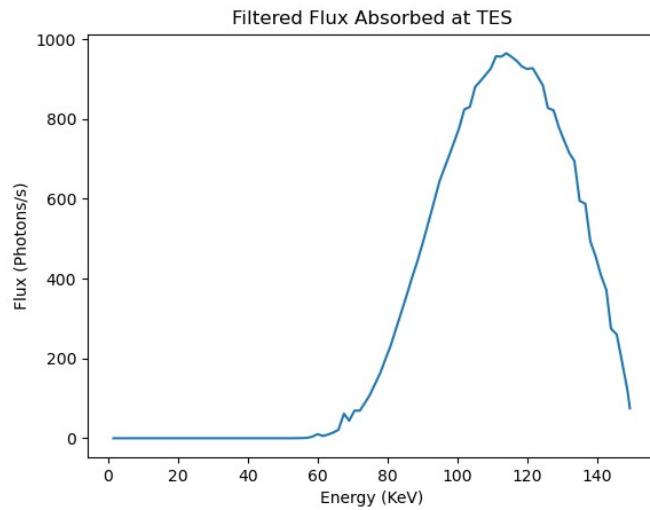
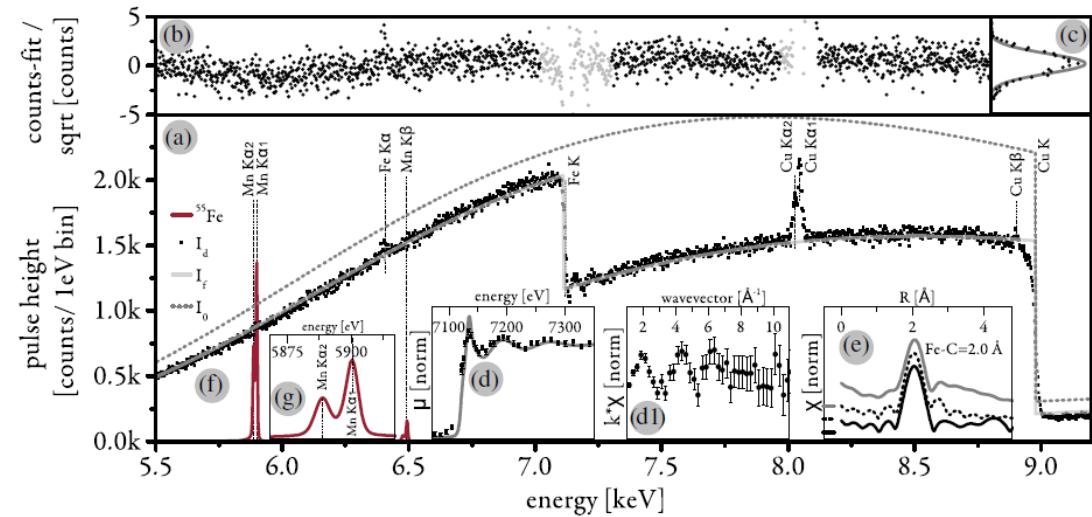
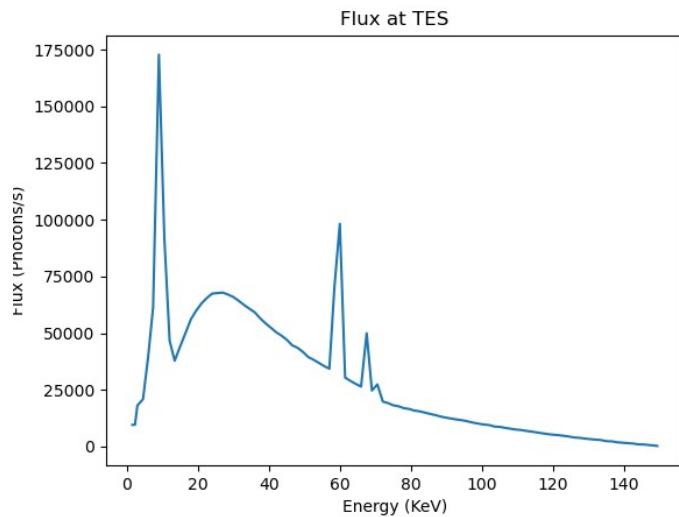
Analysis Tool Integration



Diagnostics



Next Generation Applications: EXAFS



Acknowledgments

- Low Temperature Detector Team at Los Alamos National Lab
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