

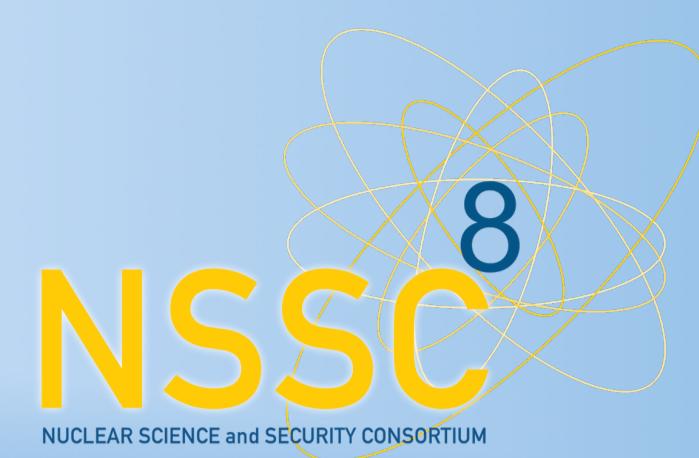


3D Gamma-ray Imaging and Scene Data Fusion

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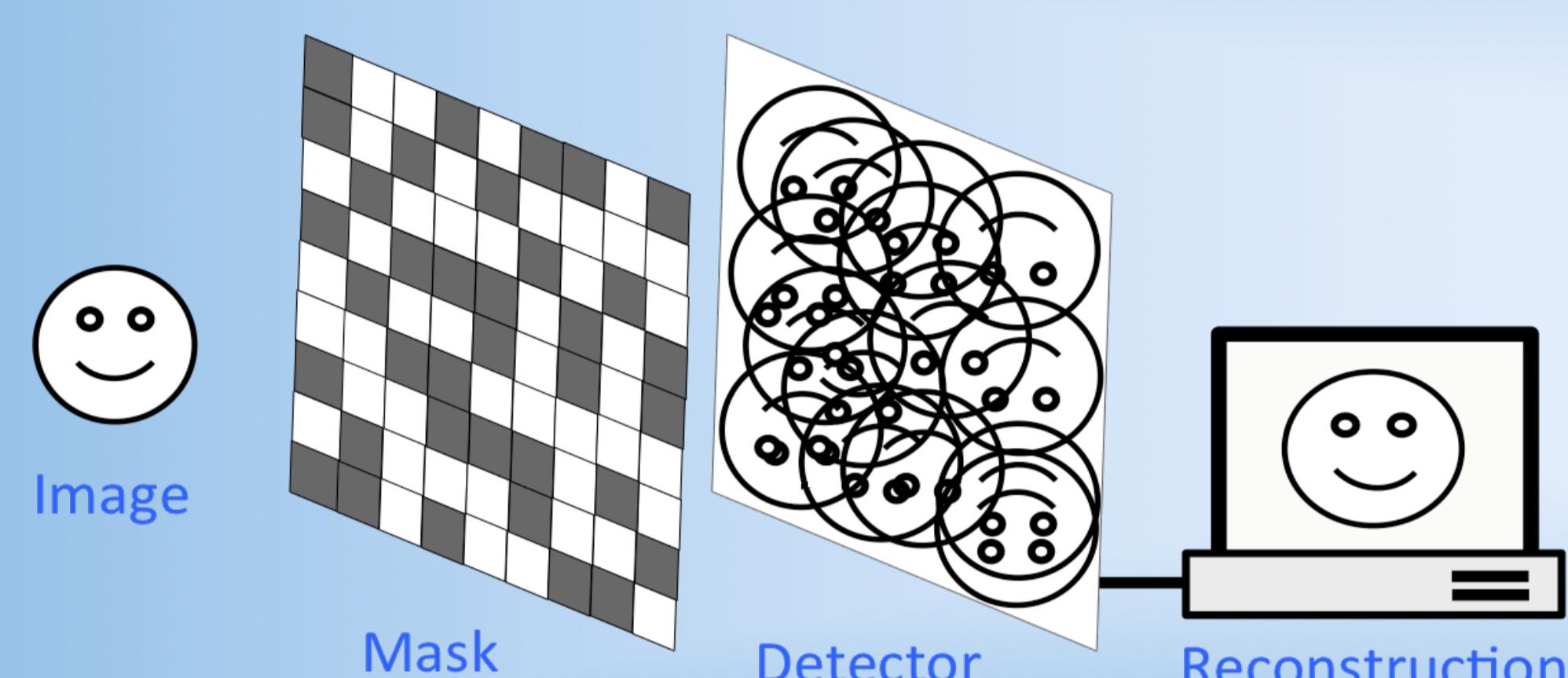
²Applied Nuclear Physics, Lawrence Berkeley National Laboratory



INTRODUCTION

Recent advancements in gamma-ray mapping technology enable faster and more efficient mapping of radiological point sources and distributions in 3D, often in near real-time. In a process called Scene Data Fusion (SDF), portable gamma-ray detection systems are combined with contextual sensors (cameras, LiDAR, etc.) to accurately localize radiological sources in 3D and constrain the reconstruction to 3D maps of the environment. Simultaneous Localization and Mapping (SLAM) algorithms are used to continuously map the 3D environment and track the detector position and orientation as it is freely moved through the scene. This concept has been demonstrated with multiple coded aperture and Compton imaging systems, both in the lab and in the field. Work is now being done to implement SDF with a hand-held, dual-mode, omnidirectional gamma-ray imager currently under development at LBNL.

Coded Aperture

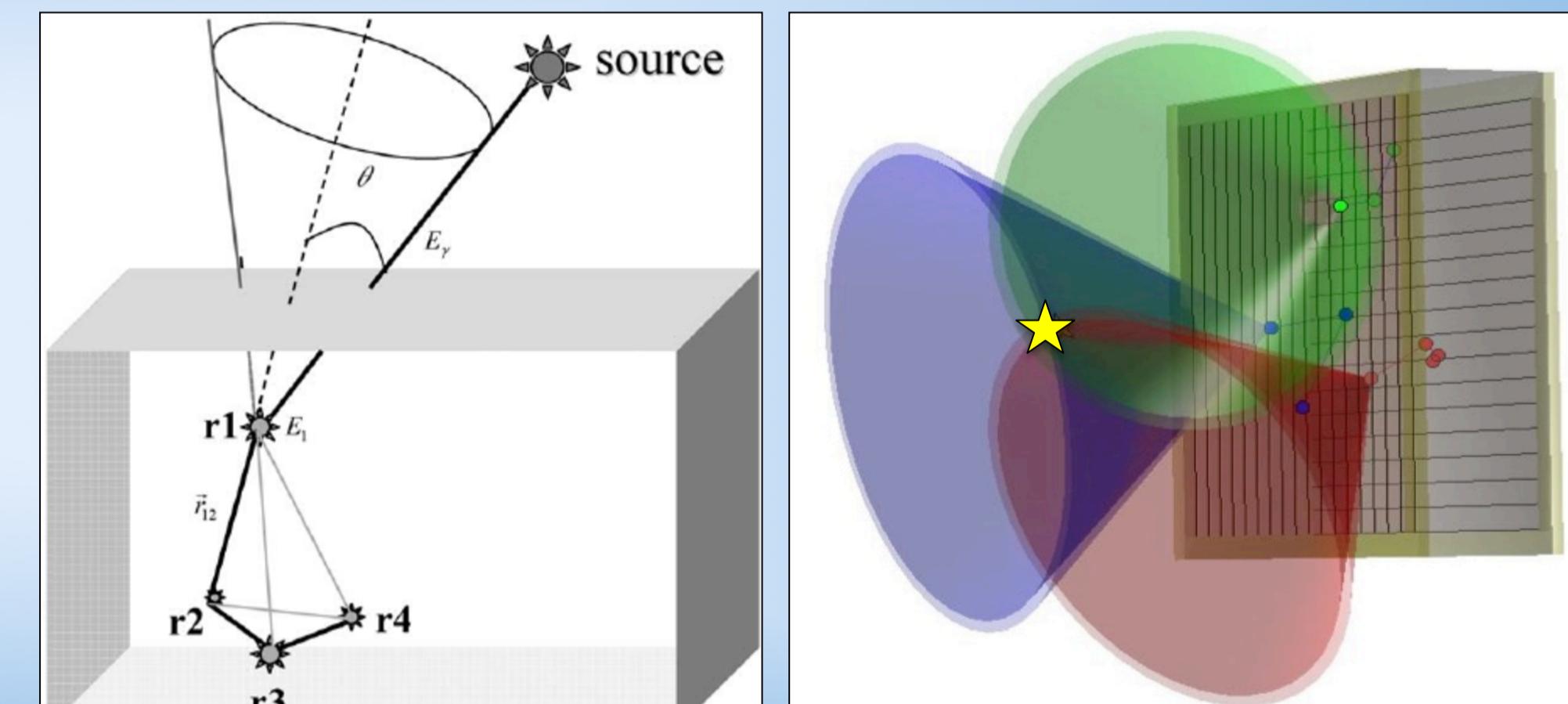


GAMMA-RAY IMAGING MODALITIES

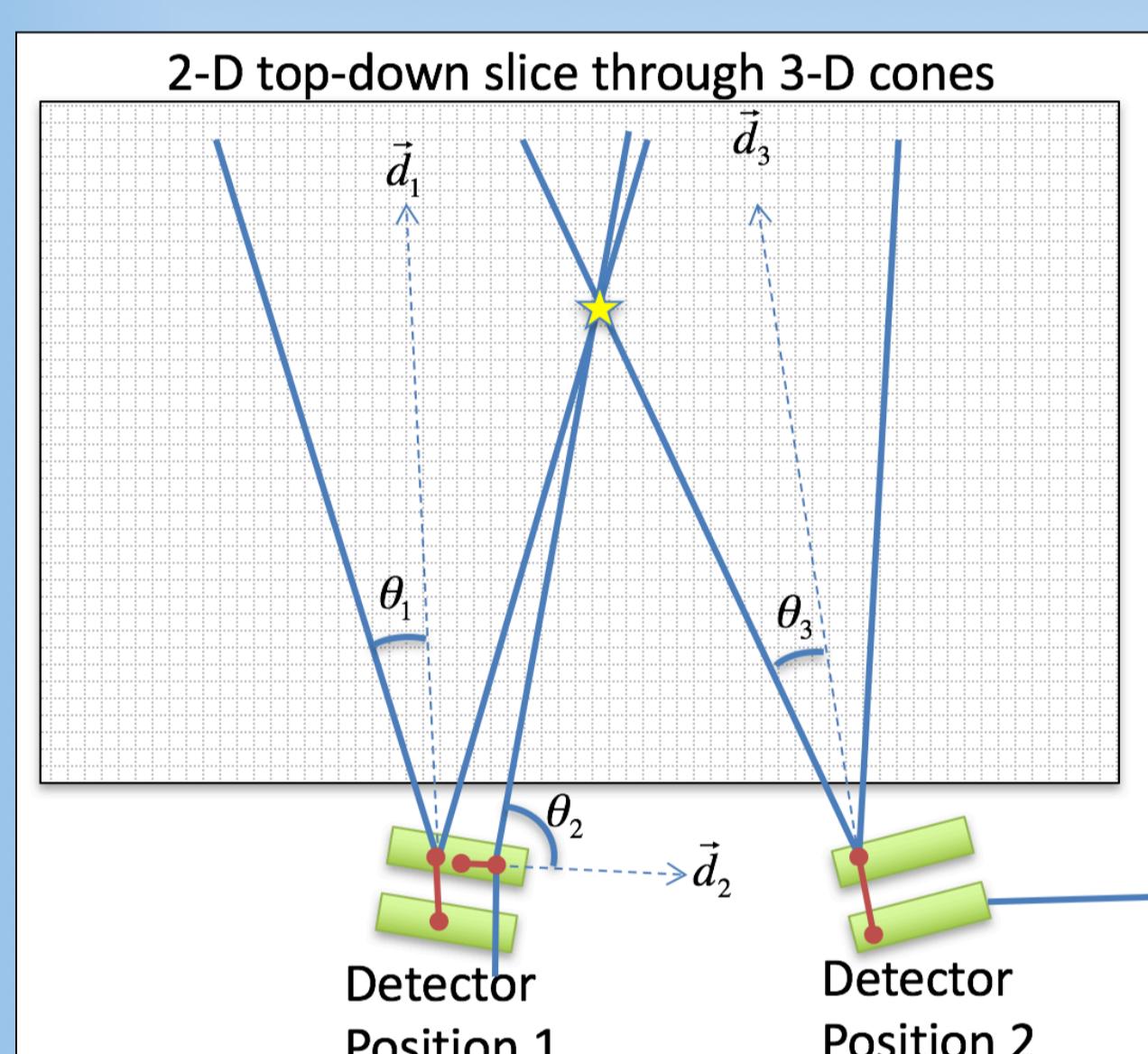
Coded aperture (**left**) utilizes an array of radiation opaque and transparent elements to cast unique shadow-grams onto a position sensitive detector. Reconstruction algorithms are used to de-convolve the detected image.

Compton imaging (**right**) utilizes photon scattering kinematics to constrain the incident radiation direction to a cone. Overlapping cones reveal the source location.

Compton Imaging

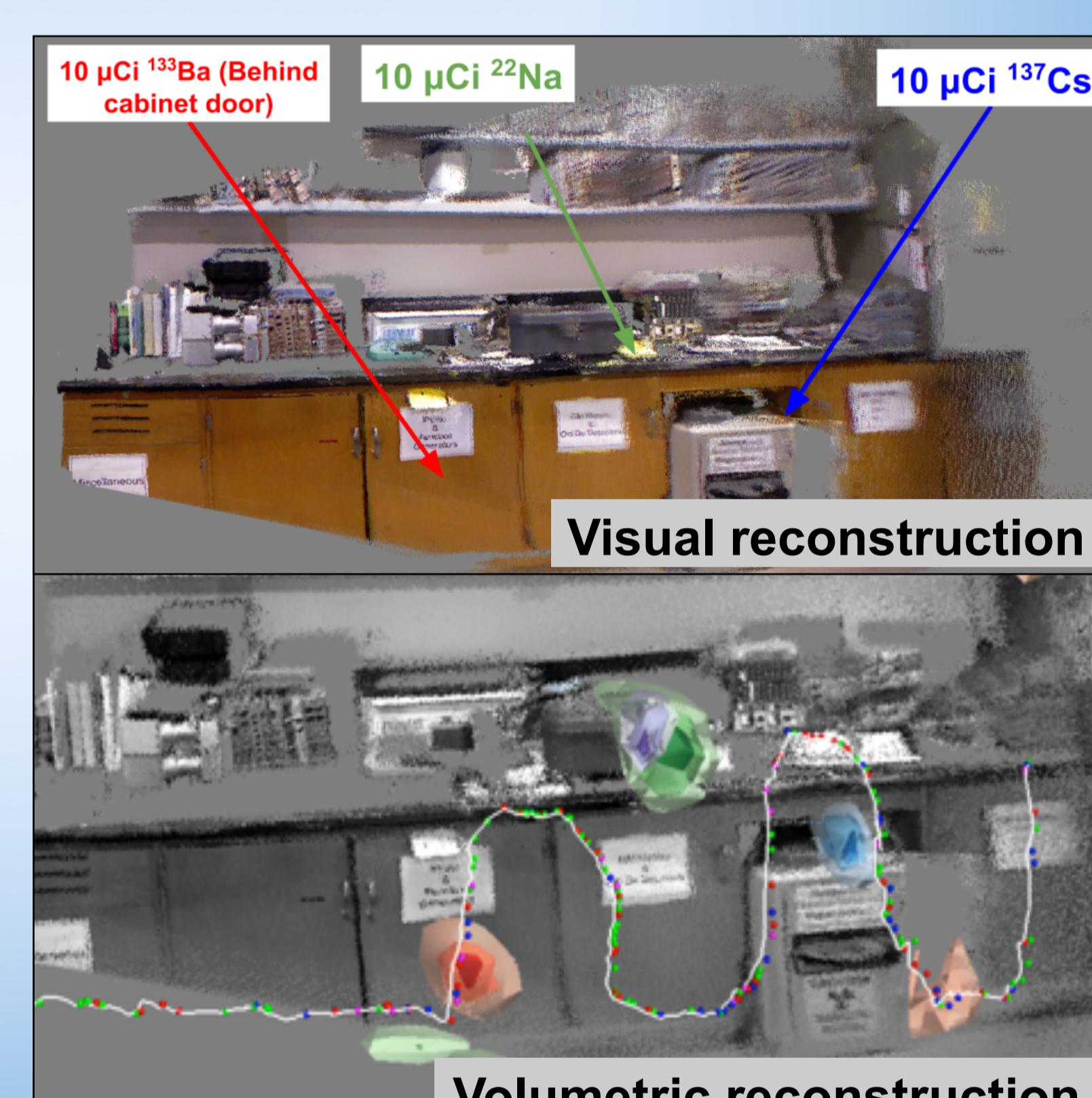


3D IMAGING AND SCENE DATA FUSION

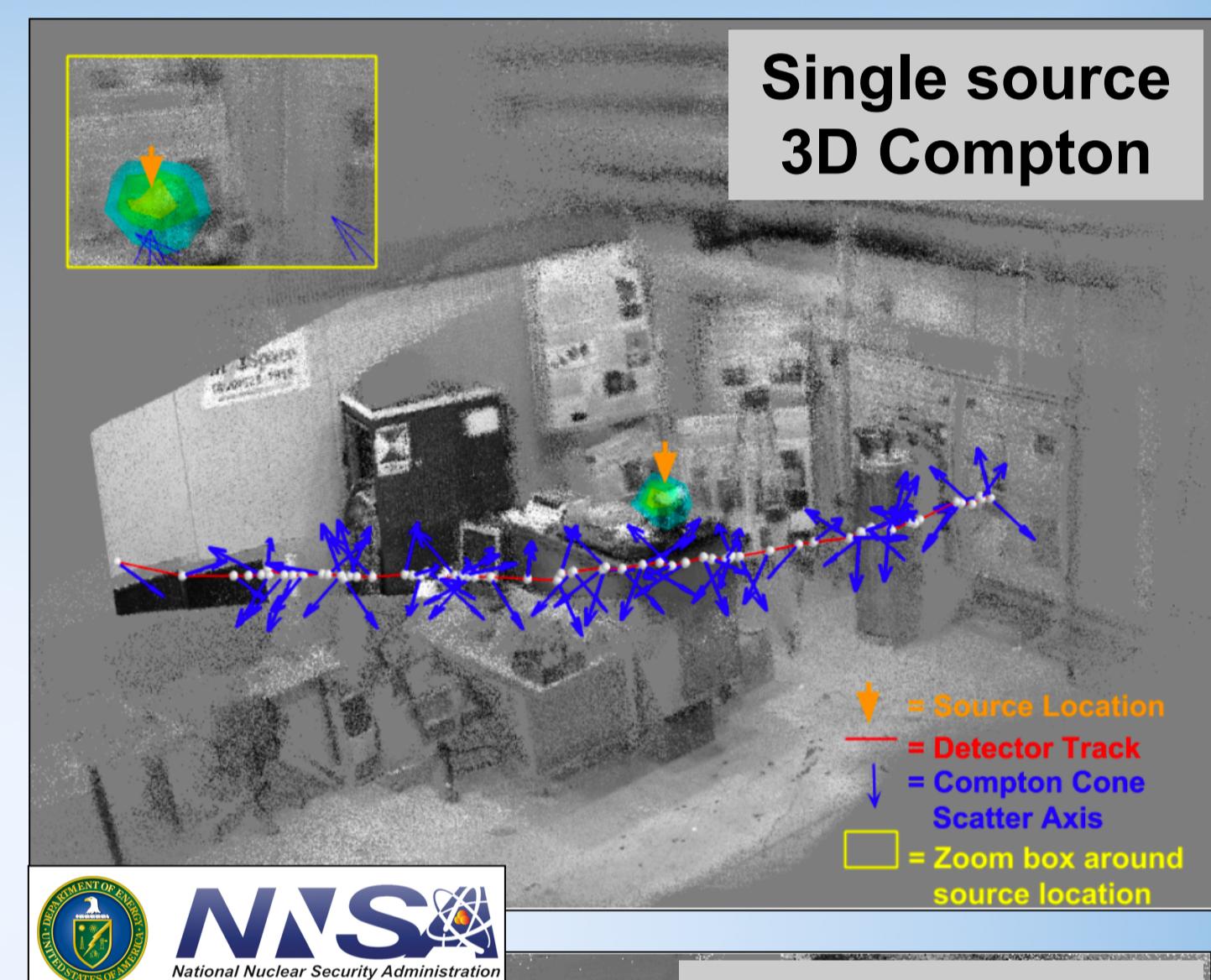
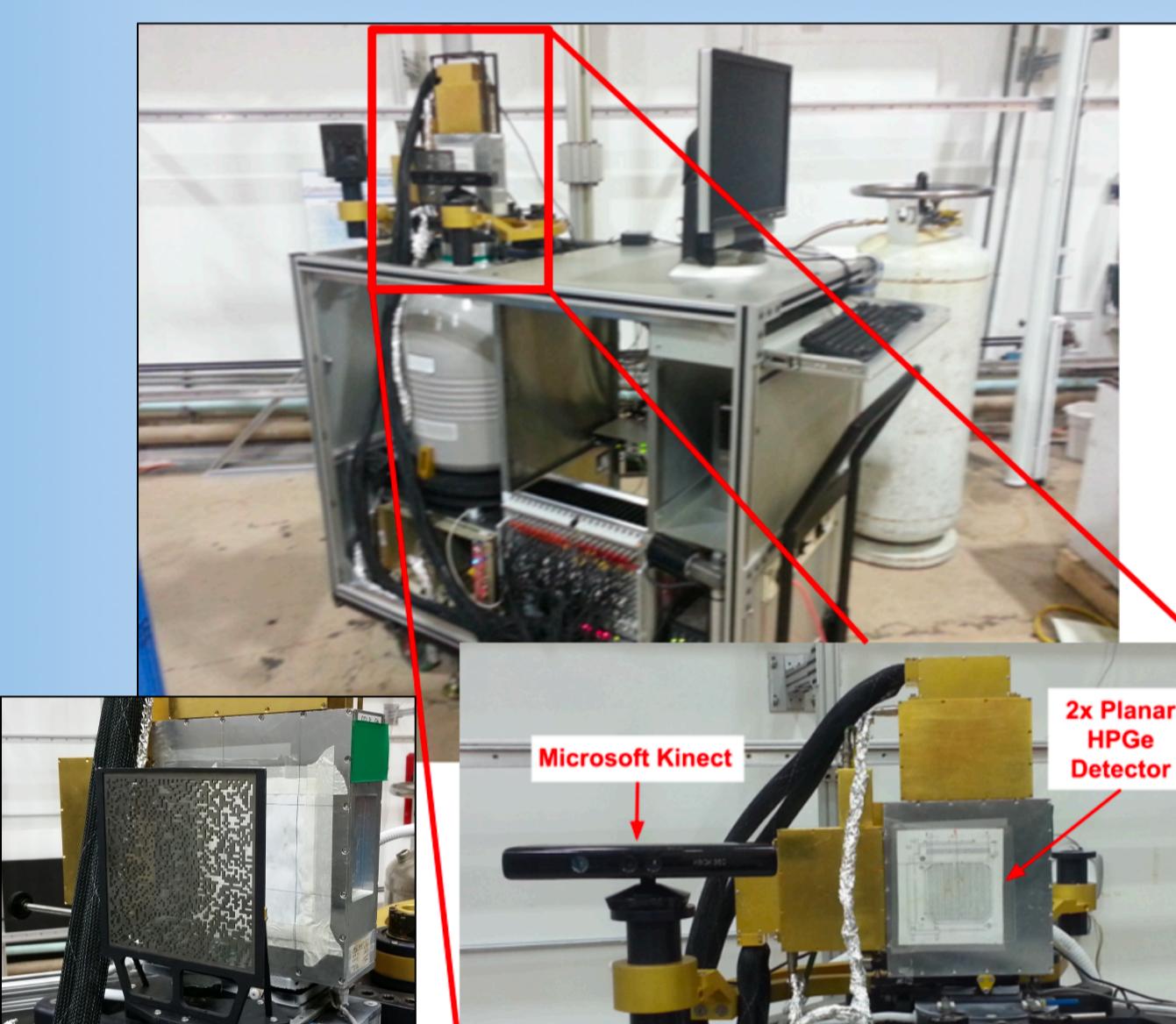


Contextual data is combined with 3D gamma-ray data in a process we call Scene Data Fusion (**right**). The image reconstruction can be constrained to occupied voxels in the 3D scene model to increase accuracy and reduce computational time.

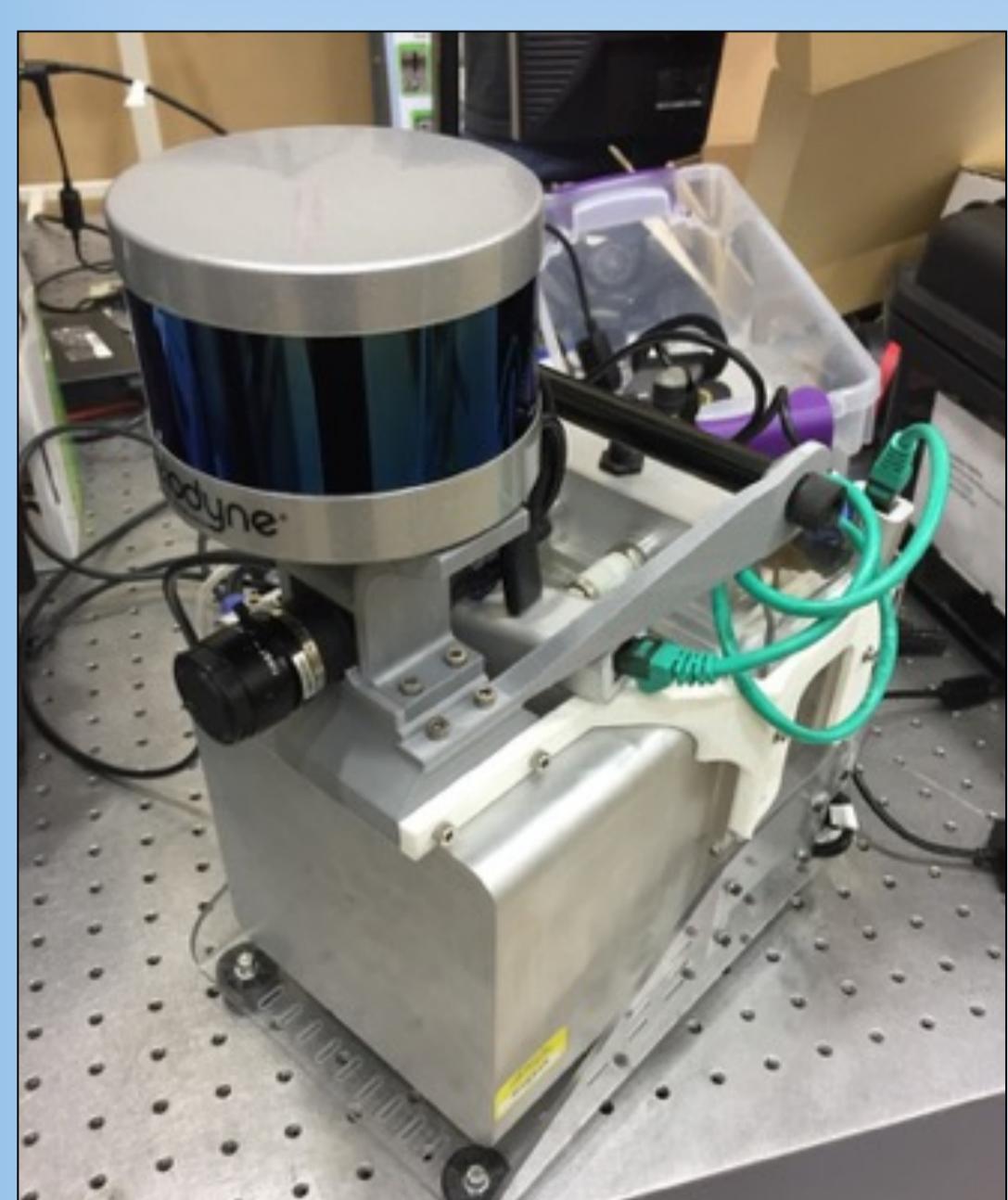
3D imaging (**left**) is achieved combining images from multiple perspectives while tracking the position and orientation of the system.



COMPACT COMPTON IMAGER (CCI-II)

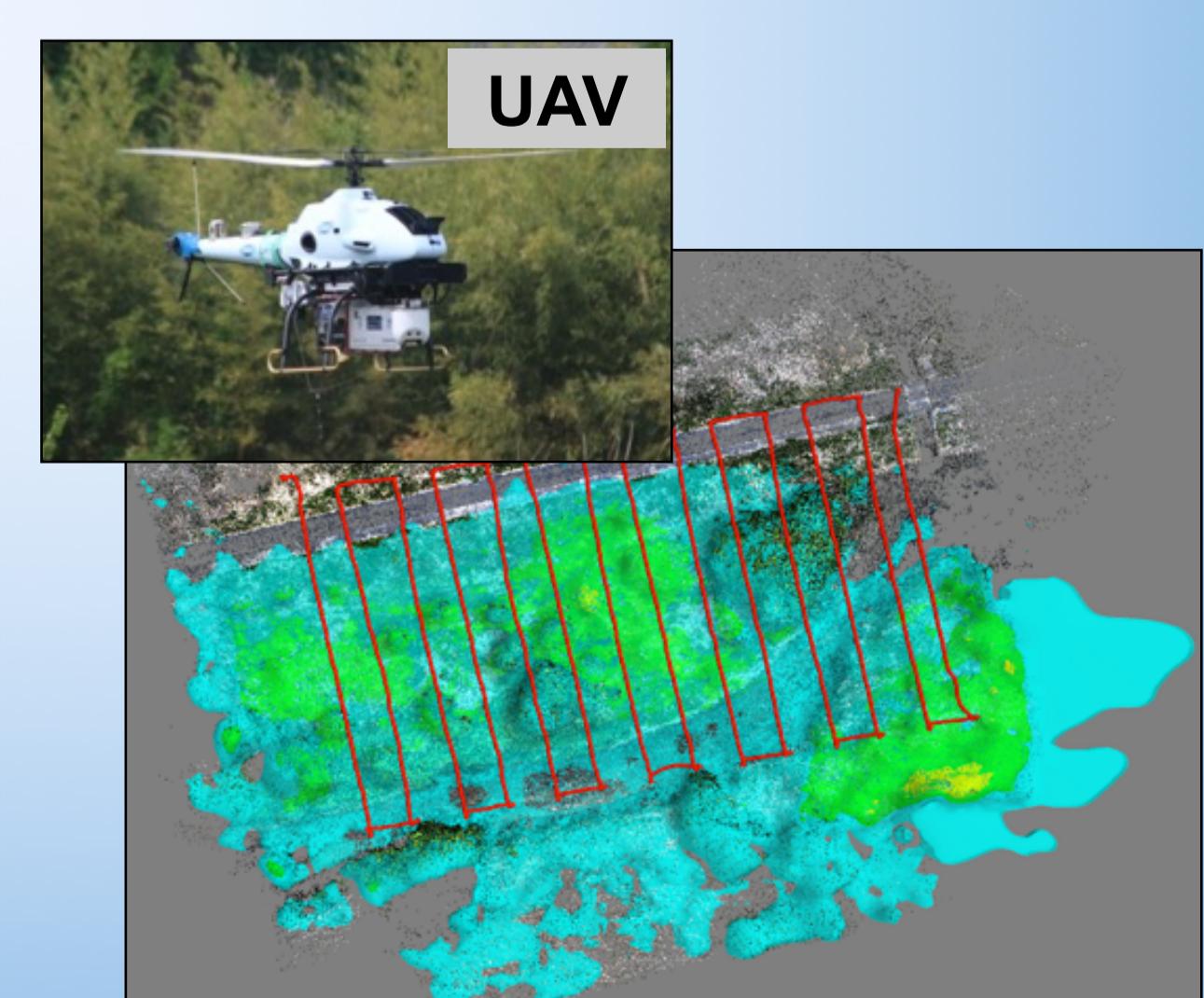
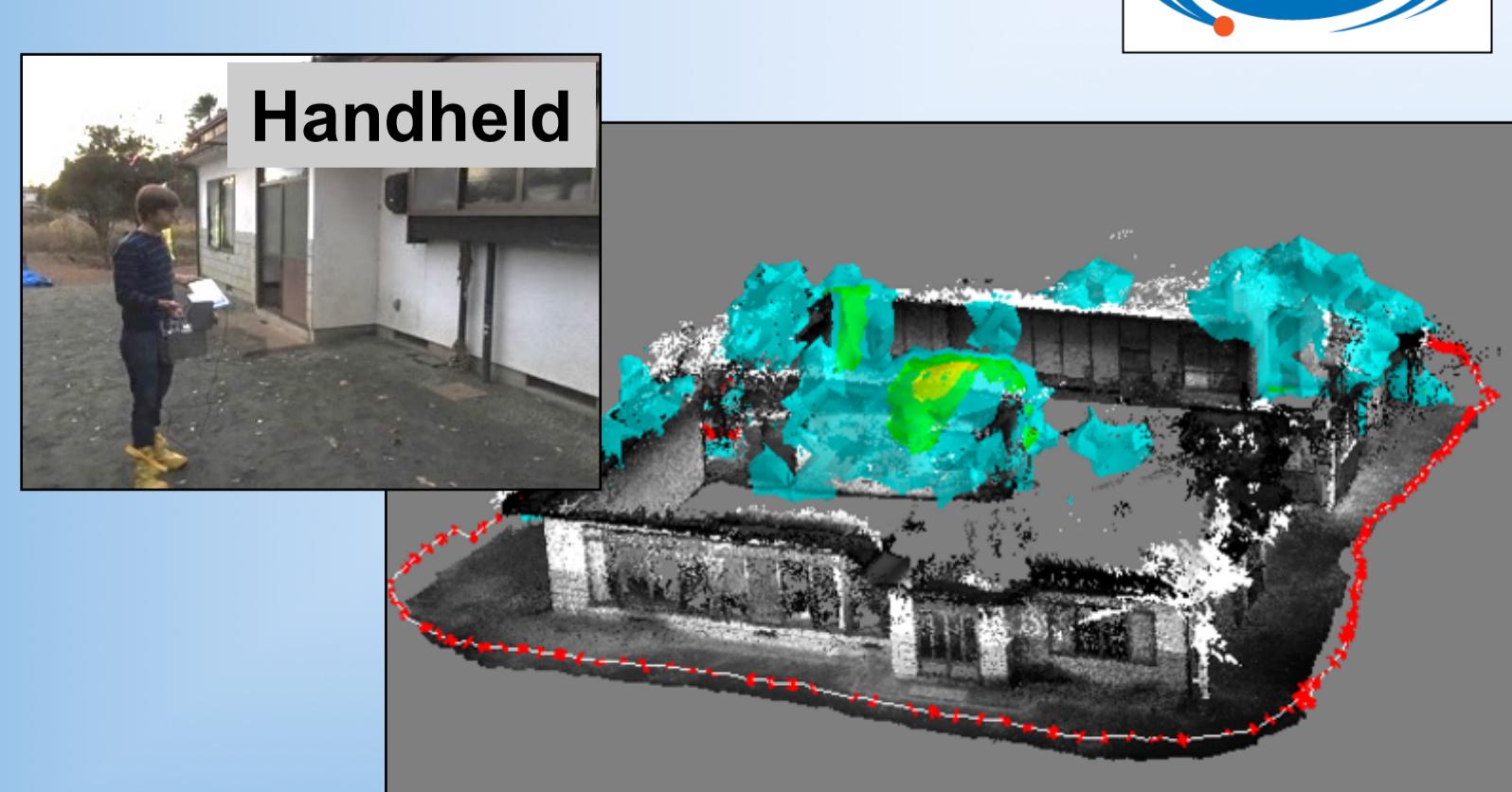


HIGH EFFICIENCY MULTIMODAL IMAGER (HEMI)



HEMI (**left**) is a hand-portable (<10 lbs) planar active coded aperture CZT-based dual-mode (coded aperture and Compton imaging) gamma-ray imaging system equipped with a visual camera, LiDAR, and IMU.

In collaboration with JAEA, 3D Compton imaging/mapping with scene data fusion has been demonstrated in both hand-held and UAV modes in Fukushima, Japan (**below**).



ACKNOWLEDGEMENTS/DISCLAIMER

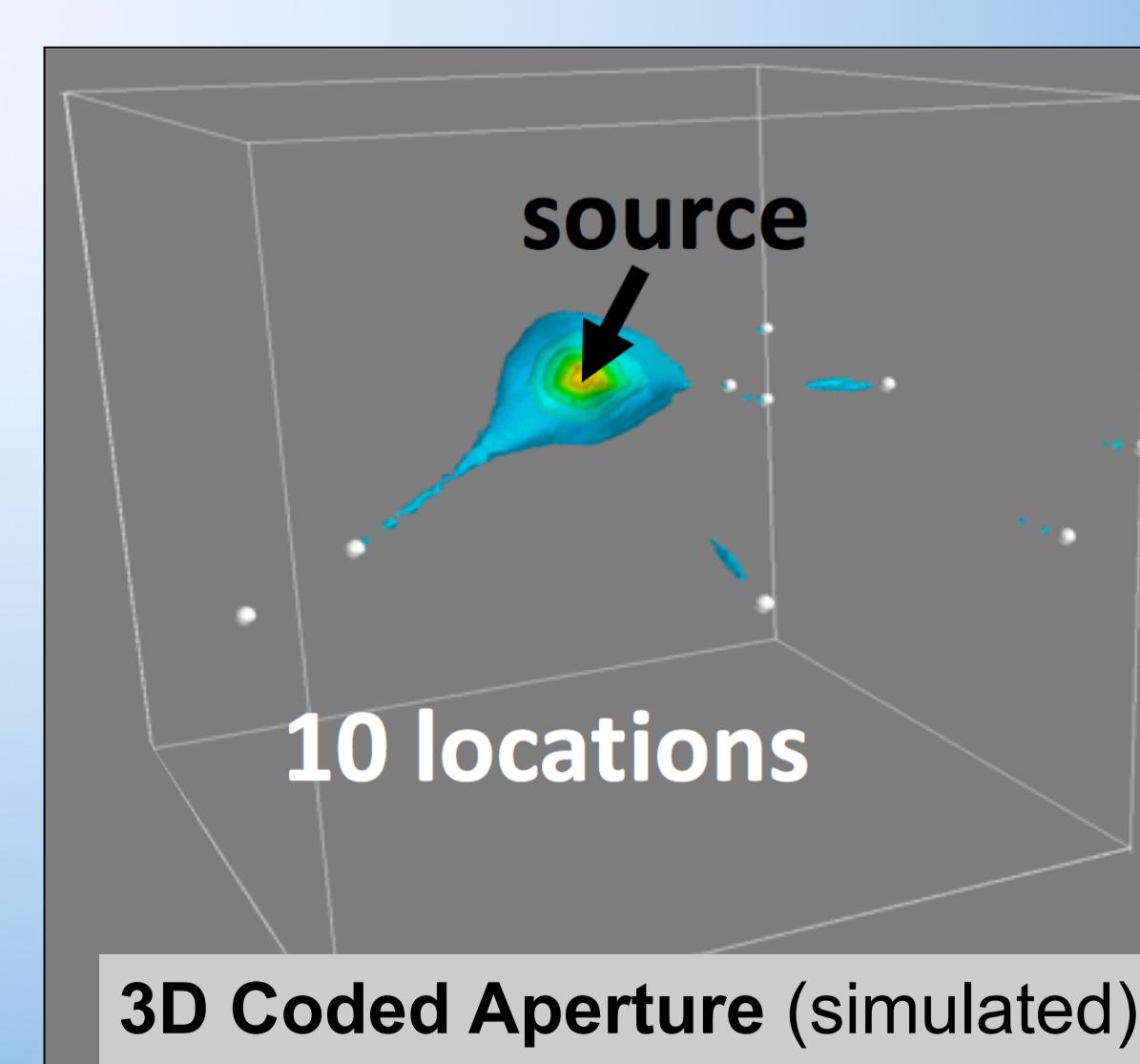
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PORTABLE RADIATION IMAGING SPECTROSCOPY AND MAPPING (PRISM)



Preliminary simulation work has been done to demonstrate the free-moving 3D coded aperture capability of PRISM (**right**).

Integration testing is currently underway - operational prototype is expected in the coming months. Experimental verification of 3D imaging with scene data fusion for both coded aperture and Compton imaging will be performed.



NSSC Program Review

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