Three-Dimensional (3D) Position-Sensitive Room-Temperature Semiconductor γ-Ray Spectrometers & Imagers

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**Unique Technology & Impacts**

An array of $2 \times 2 \times 1.5 \text{ cm}^3$ or $4 \times 4 \times 1.5 \text{ cm}^3$ CdZnTe detectors (~100 - 200 cm$^3$)

**Capable of:**

$\Delta E/E \leq 1\%$ FWHM (662 keV) at R.T. + Real-time $\gamma$ Imaging

$$\cos \theta = 1 - \frac{E_1 m_e c^2}{(E_1 + E_2) \cdot E_2}$$

**Material Research:**
Study/Characterize alternative semiconductor materials for gamma-ray detection. Such as perovskites.

Number of photons: 2033
Compact **High Resolution** CZT Detectors Delivered to **IAEA**

1) No cryogenic Cooling (HPGe)
2) Resolution superior than Scintillators
Comparison on measured plutonium spectra
Gamma & **Neutron** Detection on the Same Detector

![Graph showing gamma and neutron detection](image)

- **CZT**
- **HPGe**
- **$^{113}$Cd(n, $\gamma$)$^{114}$Cd**
- **Thermal Neutrons**
Real-Time Imaging on Gamma-Emitting Isotopes

Optical & (^{60}Co) Gamma Images at Fermi Nuclear Plant
Chernobyl Arch by Dr. Willy Kaye of H3D Inc. in 2019

Optical + Compton Image 250 – 1500 (keV)

49267 Imaged Cts; Dose 250-1500 keV; Arch; 36:06
Explore Alternative **Semiconductor** Materials

**CsPbBr$_3$** perovskite semiconductor detectors

- 8×8×9.63 mm$^3$
- 14×14×13.1 mm$^3$
- 8.5×8.5×13.2 mm$^3$

Only YH-UM-4 operated at **350** V

**From Northwestern University**

**Pix. 6**

YH-UM-4

- 1.9% FWHM

**Pix. 9**

YH-UM-4

- 2.0% FWHM

Hole life time $\tau > 120$ μs & mobility $\approx 22$ cm$^2$/V·s

Observed $\mu_h \cdot \tau_h > 2.6 \times 10^{-3}$ cm$^2$/V
Looking for collaborations:

• Applications using high-resolution imaging gamma-ray spectrometers

• Integrated 3-dimensional gamma-ray imaging and isotope I.D. with spatial awareness (Inertial measurements unit (IMU), Simultaneous Localization and Mapping (SLAM), etc.)