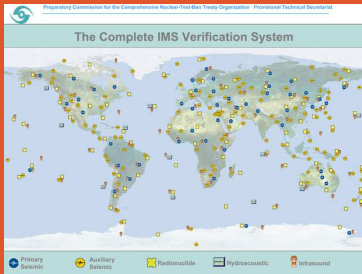
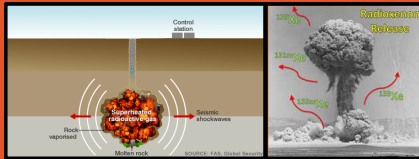


GLOBAL NUCLEAR AWARENESS AND THE IMS

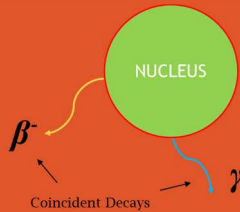
- **CTBT** – Ban on all nuclear activities
- **International Monitoring System (IMS)** – Global array of detectors



- **Radioxenon** – Byproduct of nuclear explosions (^{131m}Xe , ^{133}Xe , ^{133m}Xe , ^{135}Xe)



- **Atmospheric Detection** – Requires extreme sensitivity (≤ 1 decay, per second, per meter cubed atmosphere)
- **Beta-Gamma Coincidence** – Virtually simultaneous radiation release; extremely unlikely in background



- **Ideal Detector** – Compact, low-cost, high resolution, low background coincidences



A COMPACT RADIOXENON DETECTION SYSTEM

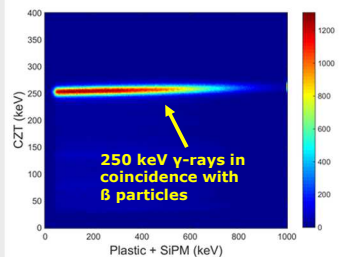
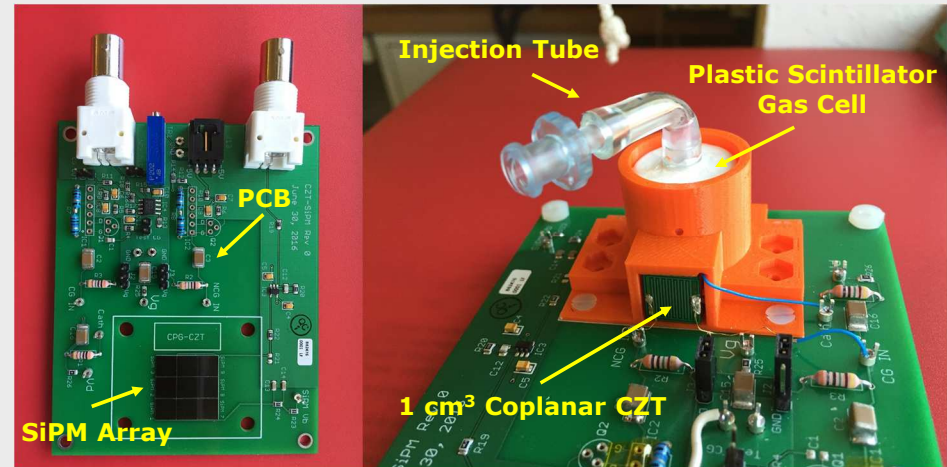
Identifying clandestine nuclear activities in support of the Comprehensive Nuclear Test-Ban Treaty Organization (CTBTO)

S. A. Czyz, A. T. Farsoni, L. Ranjbar, H. Gadey

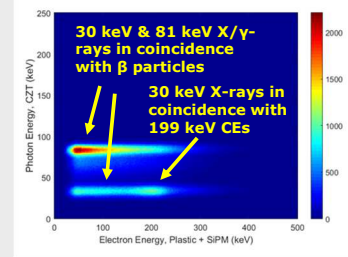
CASP: CZT, AN ARRAY OF SiPMs, AND A PLASTIC SCINTILLATOR

- **Plastic Scintillator**
 - Electron Detection
 - Low cost
 - Transparency to photons
 - Well matched with SiPM for high eff.
 - Near 4π solid angle
- **CZT**
 - Photon Detection
 - Room temperature
 - High-Z -> high res
 - Dense
- **Readout Electronics**
 - Two channels
 - Digital pulse processing
 - Identify coincidences in hardware -> very fast
- **Silicon Photomultipliers**
 - Low cost
 - Compact
 - Rugged

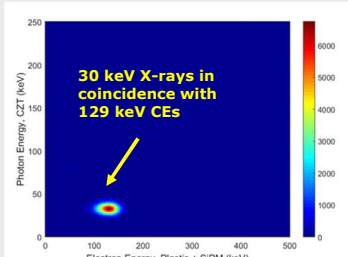
Each radioxenon sample, as well as background, were measured for several hours



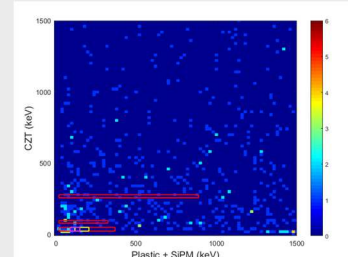
^{135}Xe



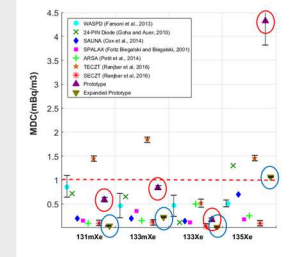
$^{133}\text{Xe}/^{133m}\text{Xe}$



^{131m}Xe



Background with Regions of Interest



MDC of CASP Compared to Others

Radioxenon Isotope	MDC (mBq/m ³) Prototype System, One 1 x 1 x 1 cm ³ CZT	MDC (estimated) (mBq/m ³) Expanded System, Four 2 x 2 x 1 cm ³ CZTs
^{131m}Xe	0.5855 ± 0.0311	0.0442 ± 0.0023
^{133}Xe	0.8383 ± 0.0269	0.226 ± 0.0008
^{133m}Xe	0.1693 ± 0.0177	0.0129 ± 0.0007
^{135}Xe	4.3211 ± 0.5702	1.059 ± 0.009

	CASP	TECZT [1][2]	WASPD [3]	Phoswich [3]	SAUNA [4][5]	ARSA [4][6]	BGW [4][7]
Background Rate (counts/s)	1.79	0.02	1.26	3.29	7.5-12	30	5.5
Total (all events) Coincidence Events	0.00355	0.0036	0.02	0.06	0.03	0.1	0.025
Coincidence / Total	0.002	0.018	0.0159	0.0182	0.004-0.0025	0.0033	0.0045

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 [3] B. Schwaninger, A. T. Farsoni, L. Ranjbar, and E. H. Becker, "A Small-Type Phoswich Detector for Nuclear Explosion Monitoring," *J. Radioanal. Nucl. Chem.*, vol. 331, no. 2, pp. 323-332, Aug. 2014.
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CONCLUSIONS AND FUTURE WORK

- Compact atmospheric radioxenon detection system was designed, constructed, and characterized
- System achieves Minimum Detectable Concentration (MDC) of < 1 mBq/m³ for 3/4 radioxenon isotopes of interest
- Low background count rates and excellent discrimination of coincidence events from singles
- Resolution could be improved for electrons by utilizing stilbene crystal instead of plastic



Radiation Detection Group website