

# Awareness and Localization of Explosives-Related Threats (ALERT)

*A Department of Homeland Security Center of Excellence*

## Novel Features and Emerging Technologies for Opioid Detection

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# ALERT

AWARENESS AND LOCALIZATION  
OF EXPLOSIVES-RELATED THREATS

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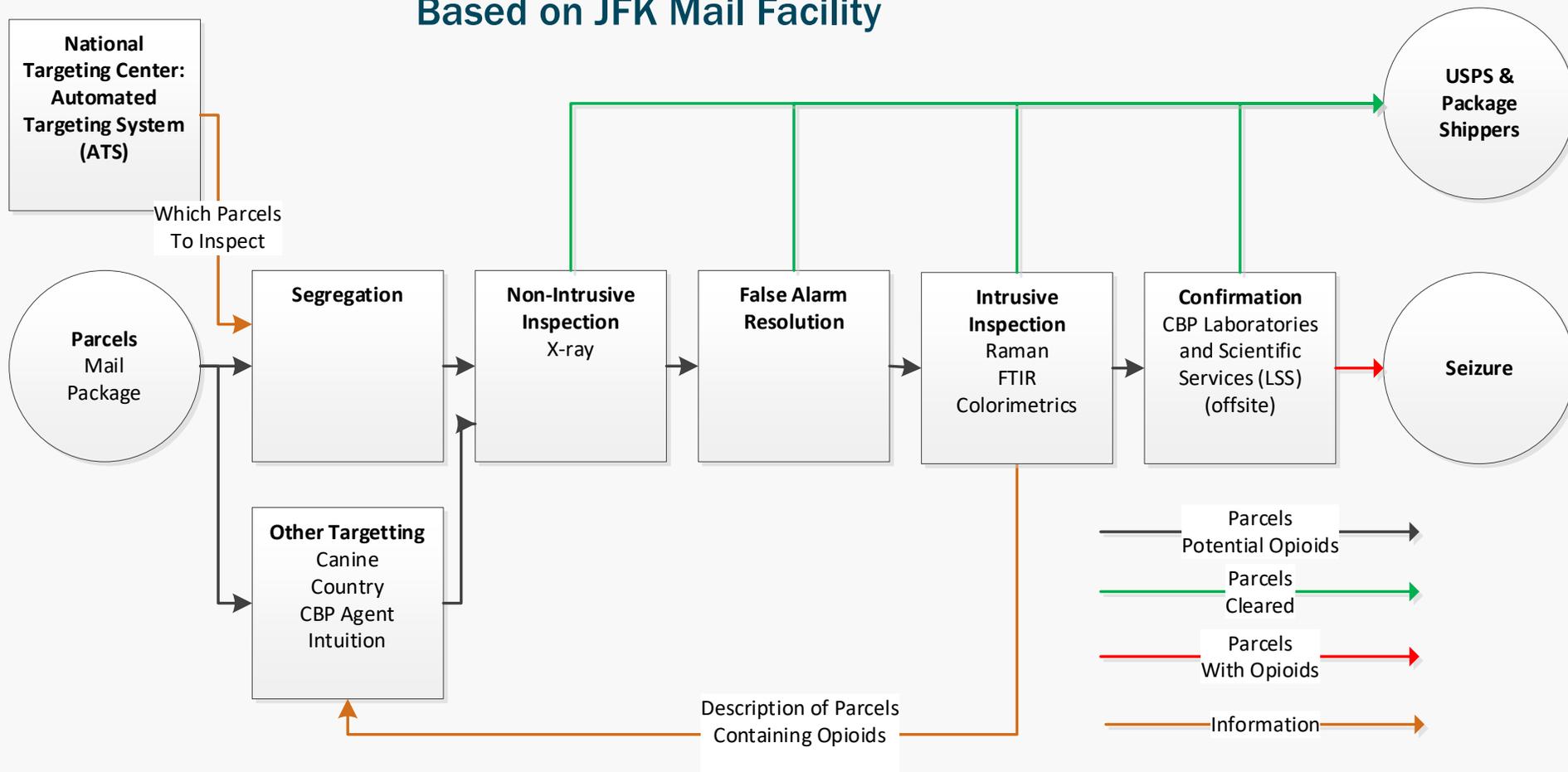
## So What? Who Cares?

- **ALERT tasked to investigate technologies for increasing interdiction of opioids at International Mail Facilities and express consignment carrier facilities**
  - New sensor signatures and sensors to detect opioids
  - Performance limits of sensor technologies
- **Several technologies identified for non-intrusive inspection that can increase percentage of parcels inspected**
  - Transmission Raman, TeraHz, X-ray scatter, X-ray diffraction, SI, vapor (in addition to existing technologies such as CT, NQR,...)
  - Effectiveness depends on packaging
- **Intrusive inspection (II) is a bottleneck (onsite and off-site)**
  - Must limit packages selected for II → very low FA rates for NII
  - Seizure rate may be better metric than PD/PFA
  - Can use fusion of NII for lower FA, plus use of false discovery rate techniques to use II on packages leading to enhanced seizures



# Sample Current Concept of Operations

Based on JFK Mail Facility



Would like: more seizures (kg/year)! How? More packages inspected, more accurate NII, better selection of packages for confirmation



# Modalities Explored in Study

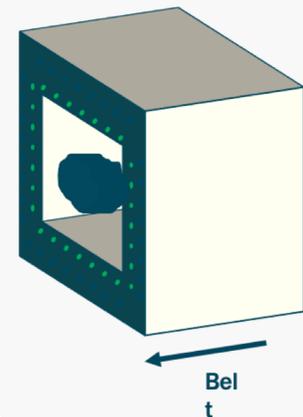
## ■ X-Ray Diffraction Tomography

- Combining X-ray computed tomography and XRD tomography for imaging and detection/classification
- Appropriate for large packages
- Simulation and experimental data with sample opioids indicates good performance (PD (0.8-1), PF (0.02-0.05))
- Technologies available from vendors with high TRL levels



## ■ X-Ray Scatter Tomography

- Attenuation, incoherent scatter and diffraction in single instrument
- New algorithms for Bragg diffraction tomography
- Appropriate for large packages
- Low TRL level, utility of scatter unclear in simulations

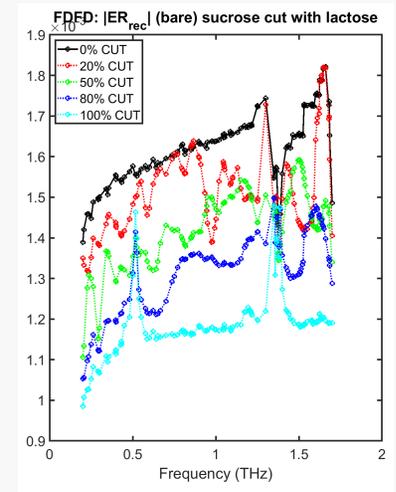




## Modalities Explored in Study - 2

### ■ Terahertz Imaging

- Used simulations of focused THz sensing, based on spectra for opioids, and computational EM models
- Processing designed to compensate for enclosure
- Limited penetration (flats, plastic enclosures)
- Good detection in limited simulations
- Low TRL



### ■ Millimeter Wave Imaging

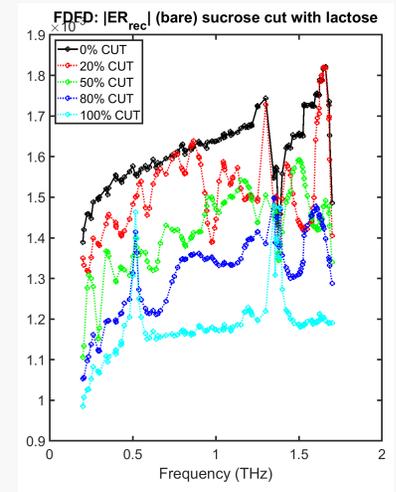
- Deemed inferior to other sensing modalities for opioid detection
- Inexpensive, but selectivity among weak dielectric items such as opioids and confusers is very limited
- Depth penetration is poor
- Can detect bulk texture (pills or powders) or metallic sheet, but inconclusive for specificity of opioids



## Modalities Explored in Study - 3

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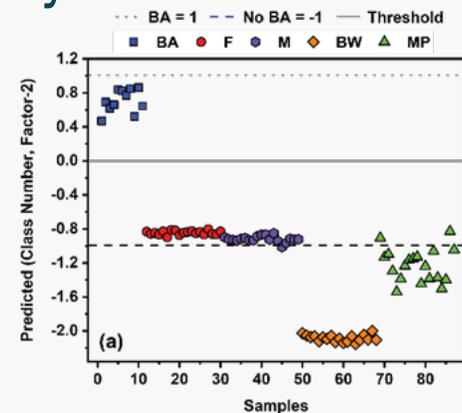
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# Modalities Explored in Study - 3

- **See-Through Raman Spectroscopy**
  - Commercial instrument used in unconventional ways
  - Limited penetration
  - Proof of concept experiments in laboratory show good detection of mixtures in flats
  - Low TRL, needs more extensive testing
  -
- **Vapor**
  - Useful for examining collections of packages
  - Performed experiments to detect vapor inside boxes
  - Vapor detected after sufficient time elapses (30 mins to hours)
  - Good for testing in transit, or in larger containers
  - Low TRL level





## Lessons Learned

- **Opioid detection is a difficult problem**
  - Many analogs, confusers, variations in packaging, part of a broader mission in CBP
- **Different non-intrusive inspection sensors are available that show promise for observing opioid-specific signatures**
  - Choice of modality depends on packaging
- **Using combinations of NII can lead to increased inspection and identification of potential packages of interest with reduced false alarms**
  - Can use for more effective selection of packages for intrusive inspection, increased seizures
  - Seizure rate may be better metric than PD/PFA
- **Final report HSHQDC-16-A-B0008/70RSAT19FR0000155 provided to DHS with further details**