

# Cargo Inspection using X-ray Backscatter

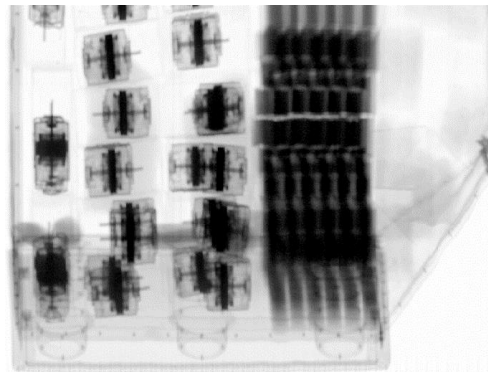
Dan Cristian Dinca  
American Science and Engineering, Inc.  
November 5, 2014



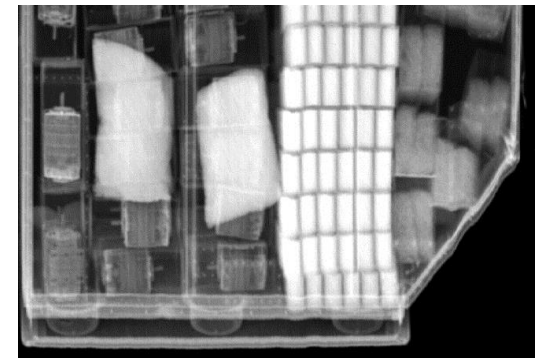
# What Benefit Could TSA Obtain From My Technology?

## Benefits of X-Ray Backscatter Imaging

- **One-sided inspection**
  - Fits multiple inspection scenarios
  - Useful when access to the far side of the object is limited or impractical
  - Smaller footprint
- **Images highlight organic materials - organic threats or contraband materials such as explosives and drugs can be more easily detected in the backscatter images than in the corresponding transmission images**
- **Photographic in appearance - easier to interpret, less operator training necessary**
- **Low dose to cargo and environment**
- **Fast scanning**



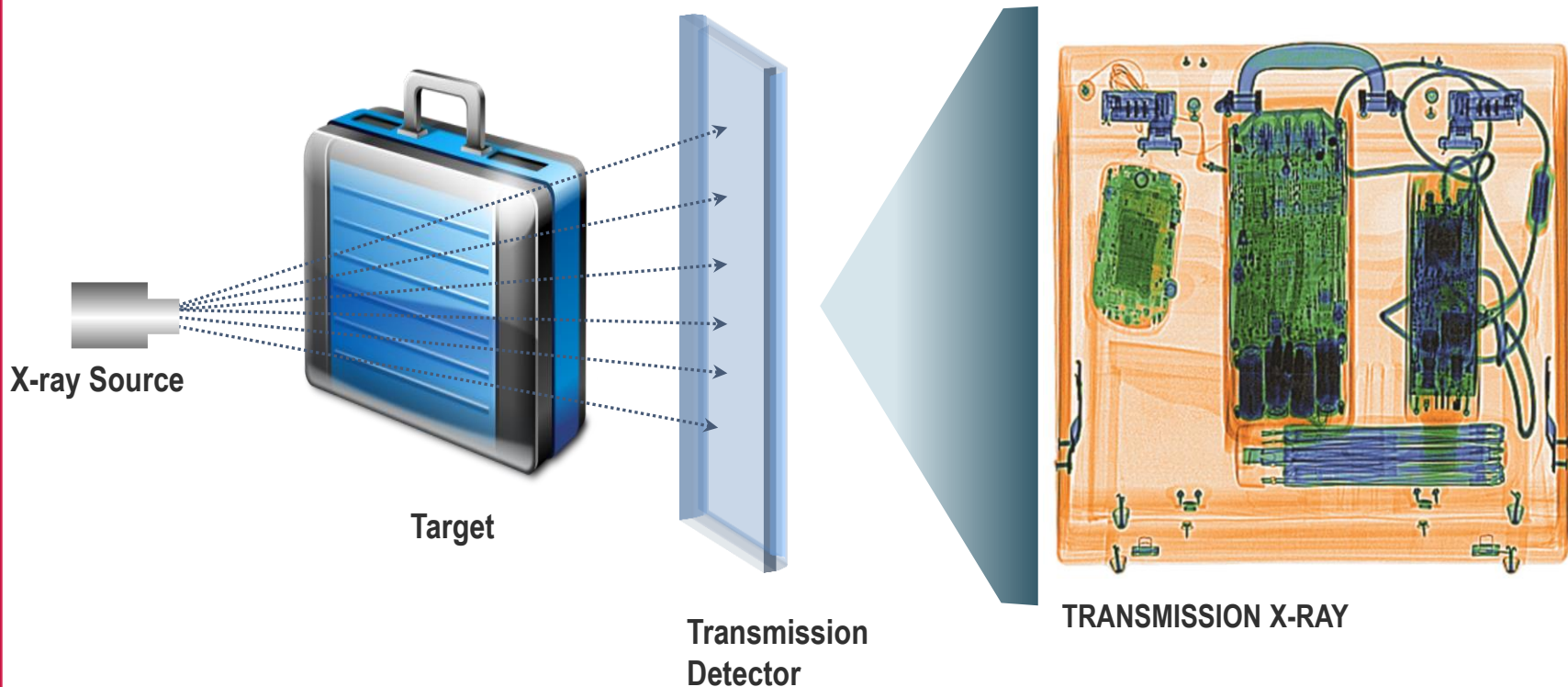
*Transmission Image*



*Backscatter Image*

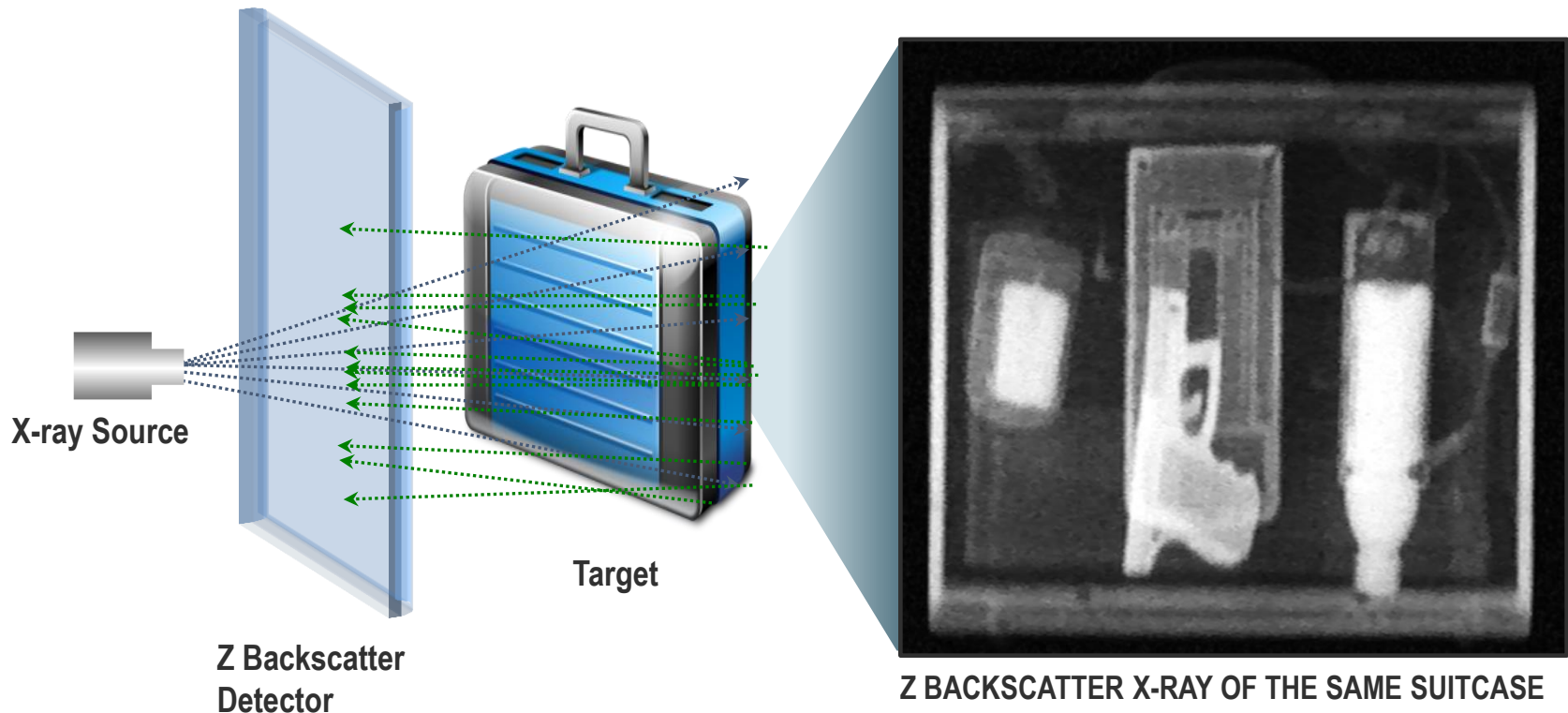
# Brief Introduction to X-Ray Backscatter

Transmission X-rays detect by passing an X-ray beam through a target to a detector on the far side.



# X-Ray Backscatter Imaging

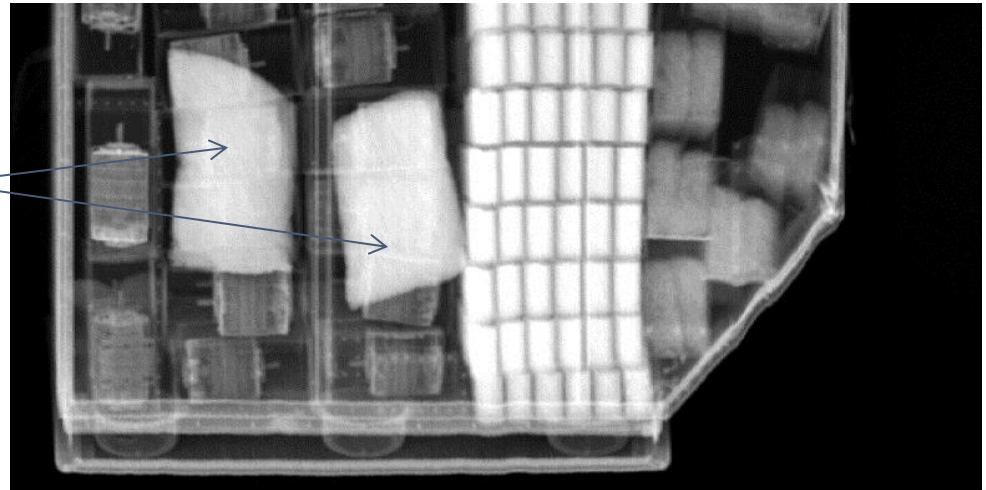
Z Backscatter X-rays detect by reflecting an X-ray beam from a target to a detector on the near side, creating a photo-like image that is easy to interpret and understand.



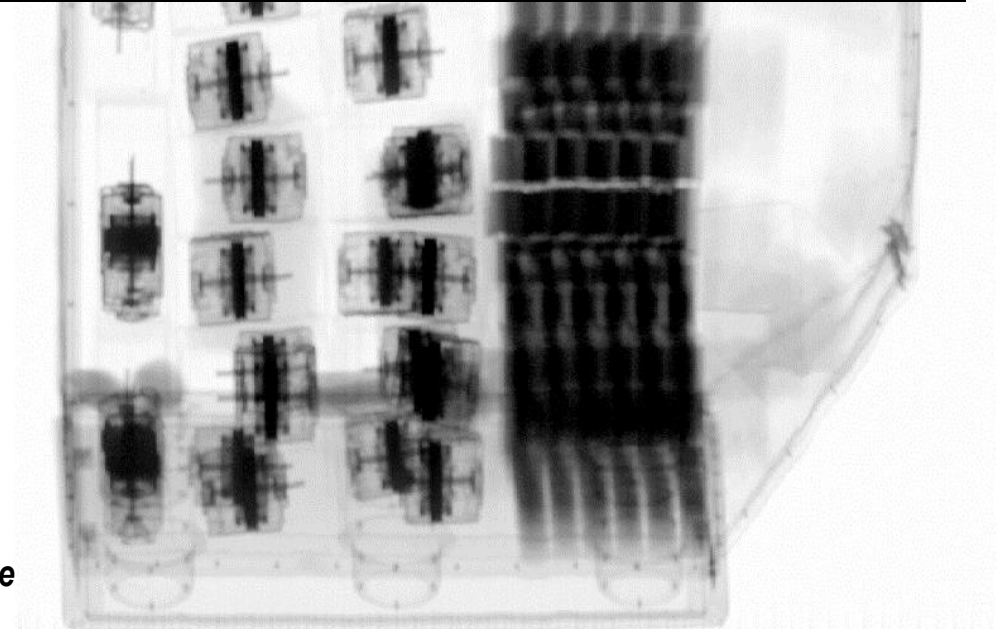


# Enhances Detection of Certain Objects in a Cluttered Environment

Explosive Simulant



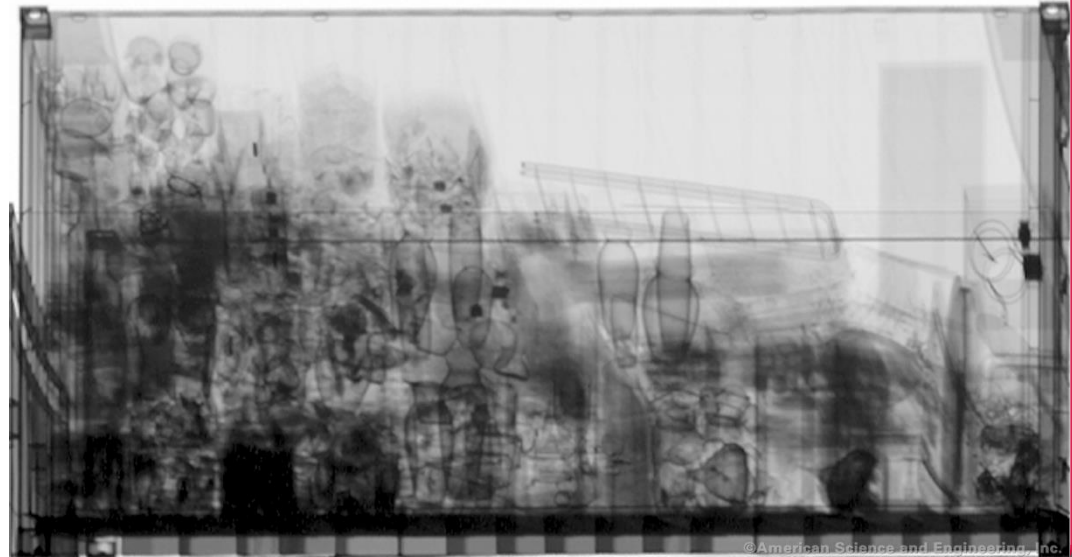
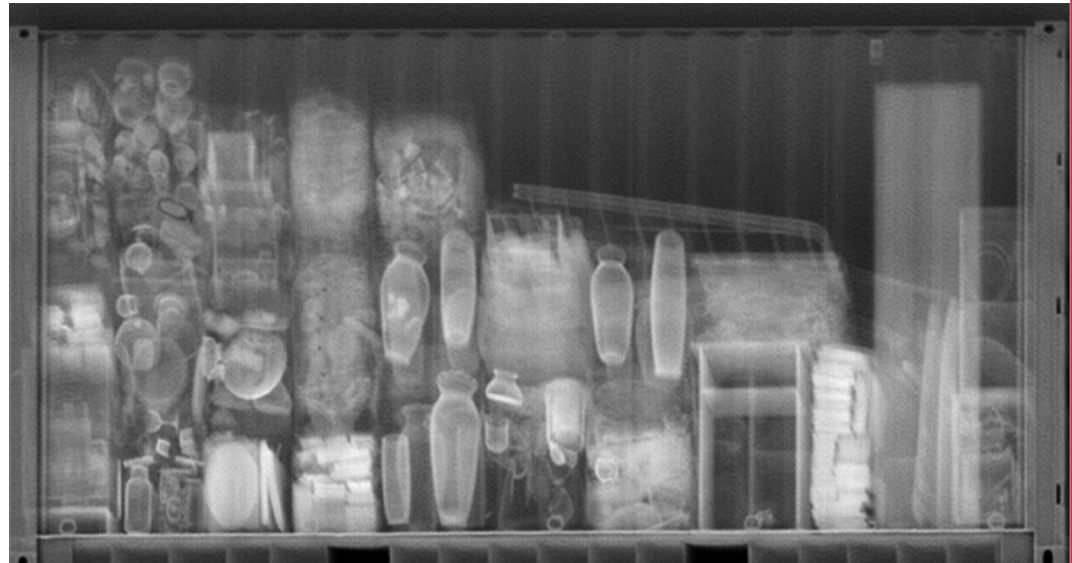
*Backscatter Image*



*Transmission Image*

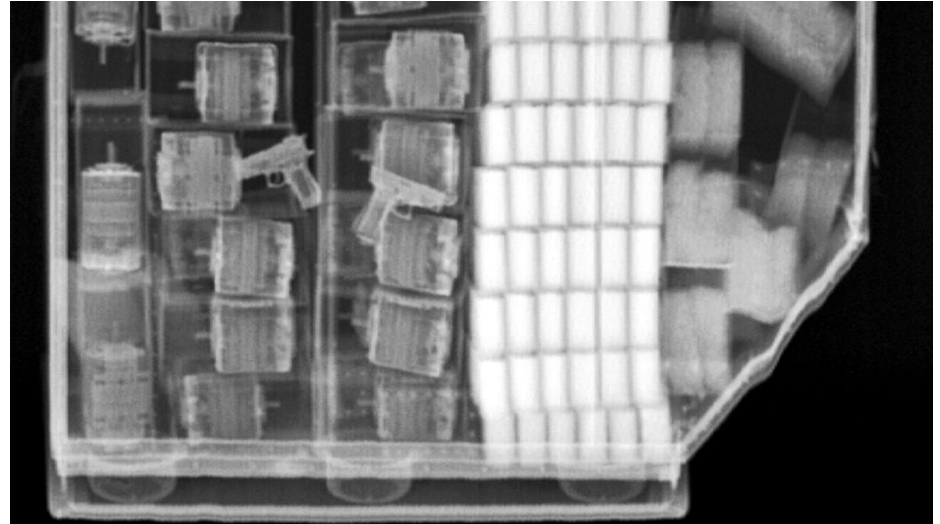
# Adds Context to a Complex Cargo Container Image

- By inspecting both the transmission and backscatter image the operator understands the context of the transmission image features

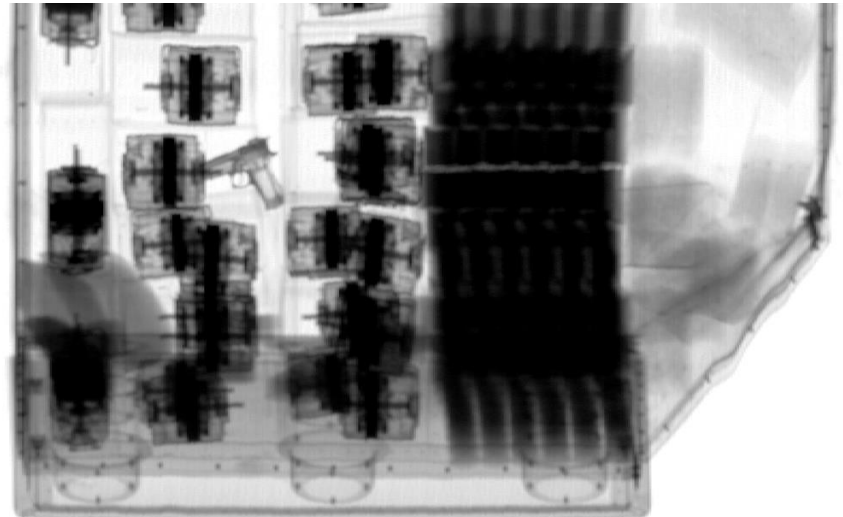


# Not Limited to Organic Objects

- Ability to detect non-organic objects depends on the surrounding environment



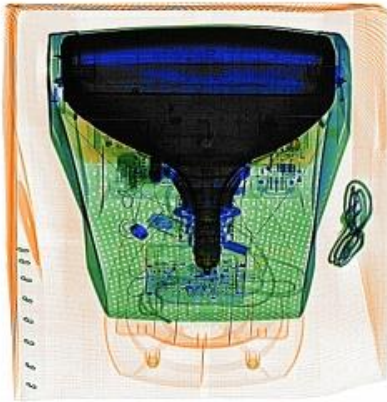
Second gun hard to notice in the transmission image



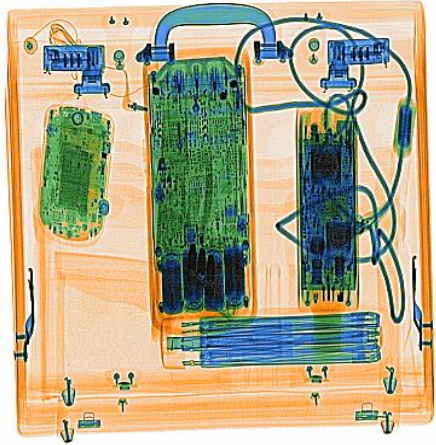
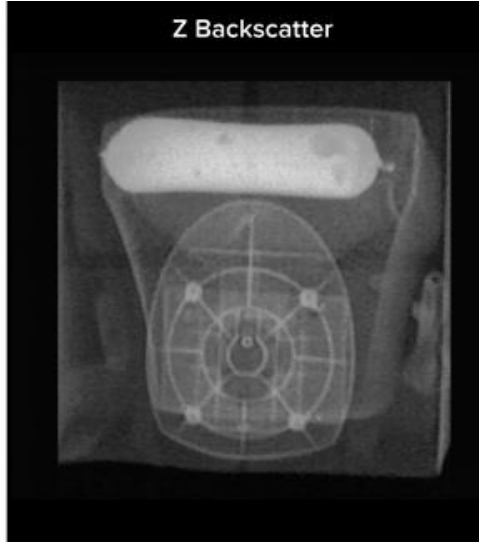


# Parcel and Break Bulk Cargo Screening

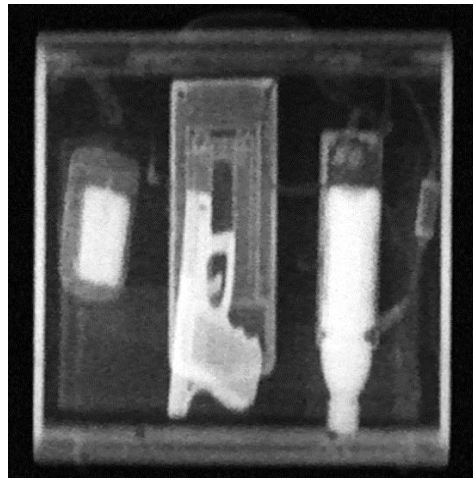
Dual-Energy



Z Backscatter



Dual-energy transmission



Z Backscatter

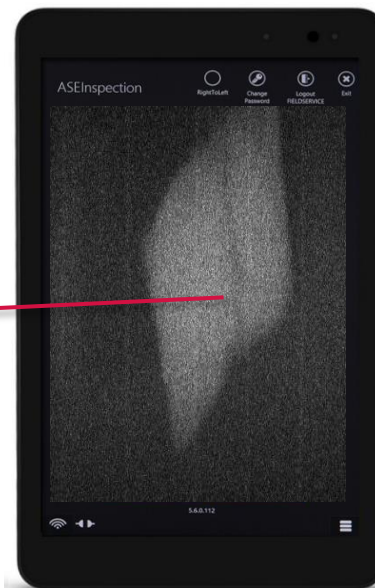
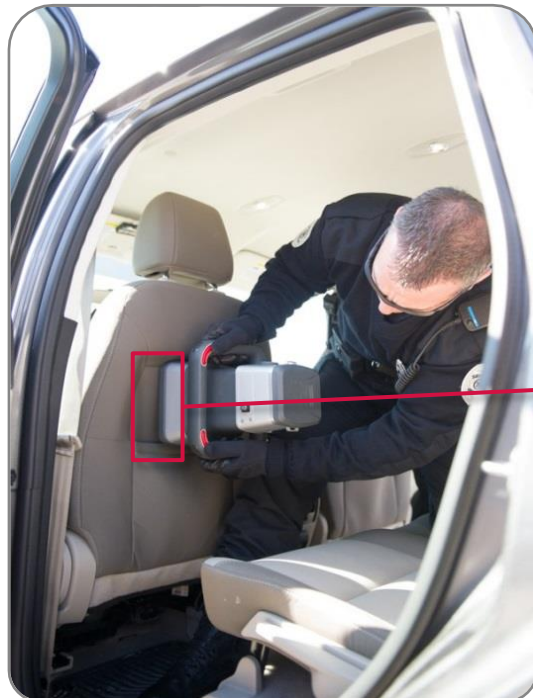




# Image Objects in Places Hard to Screen

Fast, portable detection of organic objects (drugs, explosives, etc.) located in voids behind non-metallic surfaces

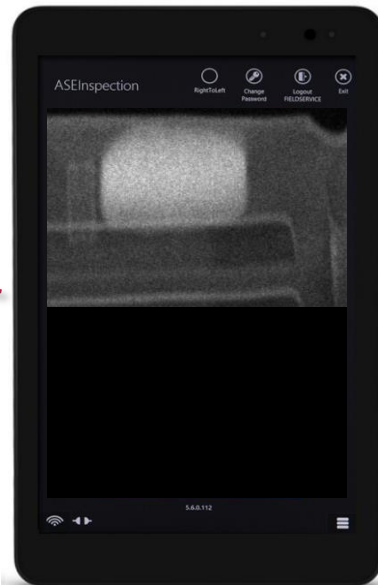
- Examination of walls, vehicle interiors, airplane interiors, pleasure boats, packages, furniture...



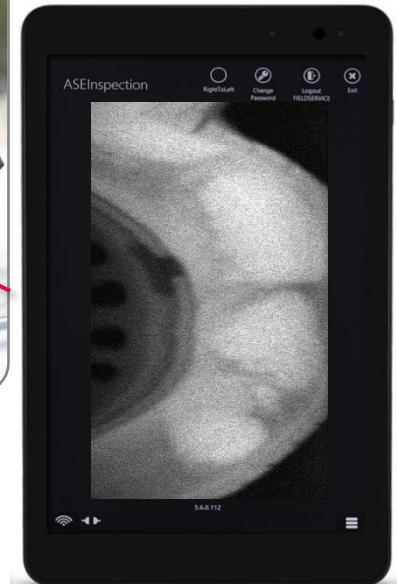
Narcotic simulant in a car seat



# See Through Non-metallic or Thin Metallic Objects and Produces Images of Potential Threats and Contraband



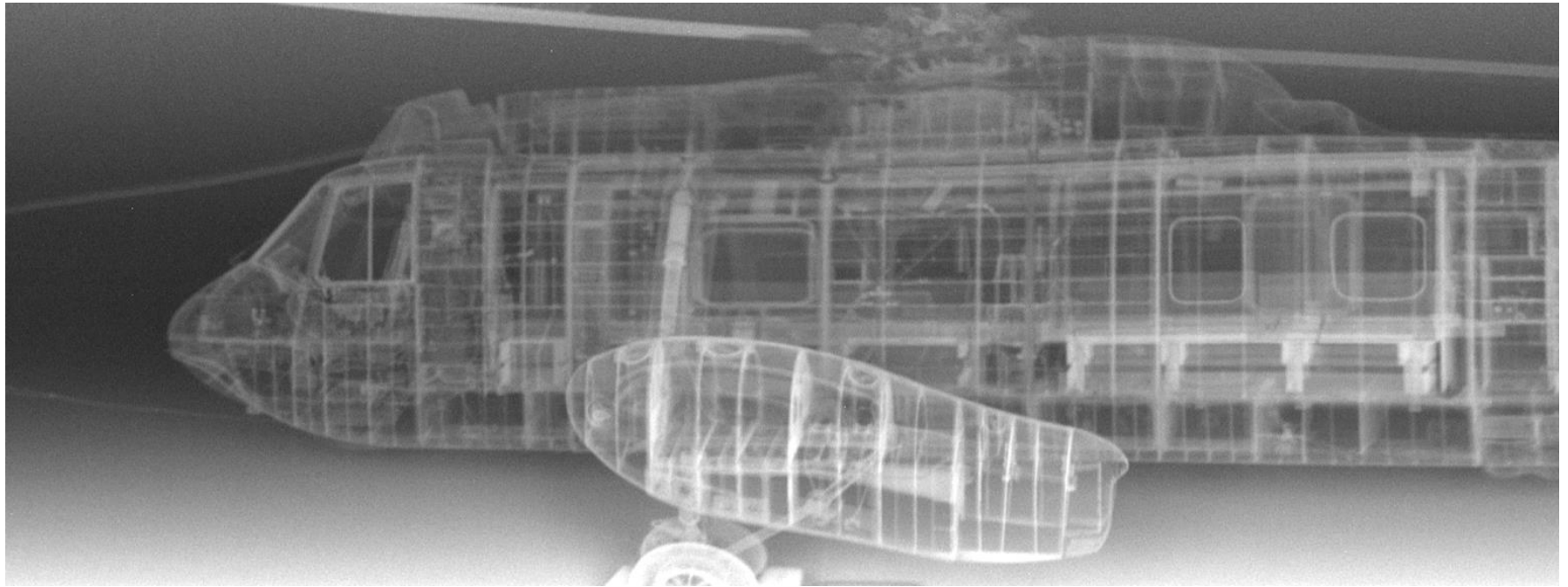
Narcotic simulant in bumper



Narcotic simulant concealed in tire

Dose to operator less than 50 urem/h for 100% duty cycle

# A Quick Way to Examine Large Objects

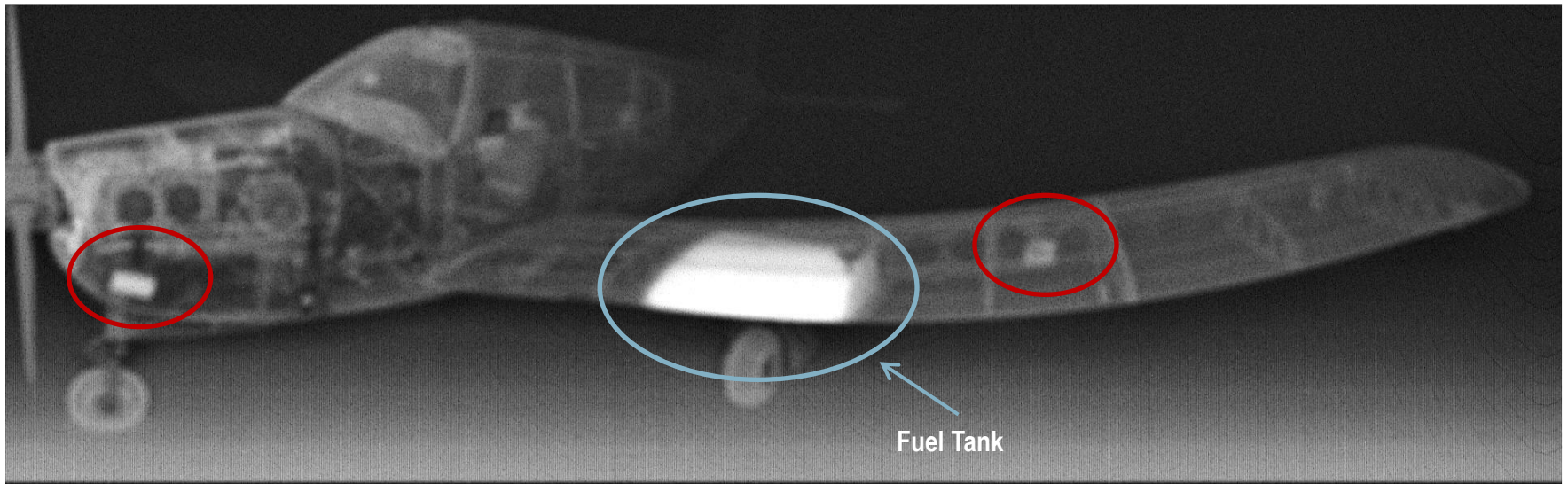
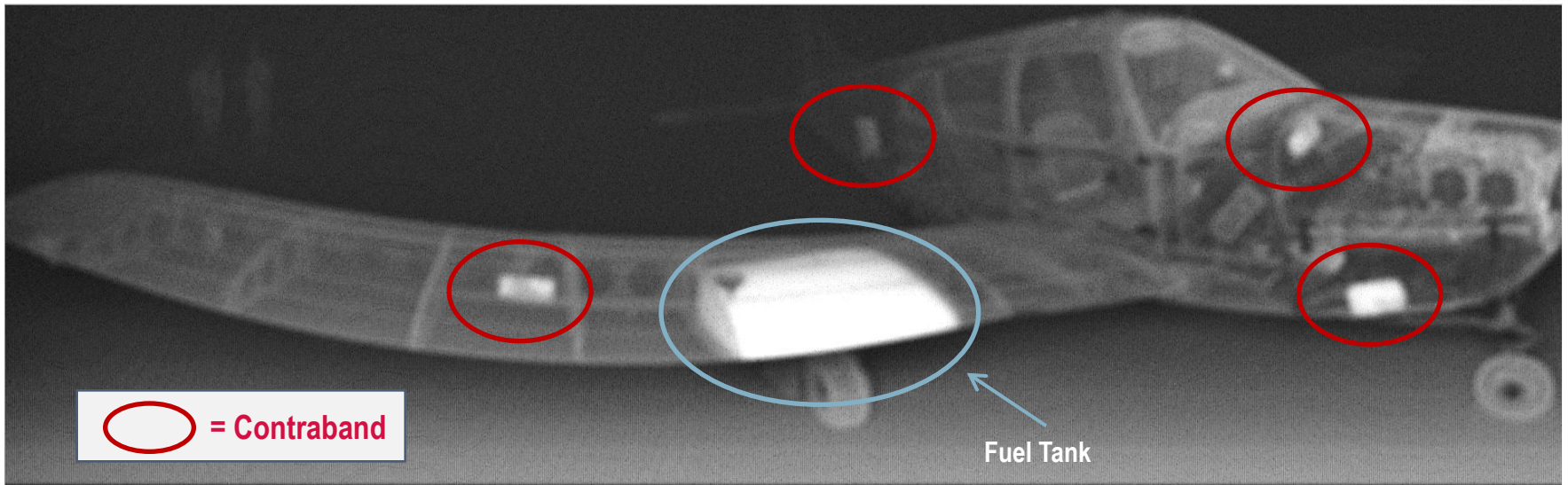


**One-sided imaging allows for simple inspections**



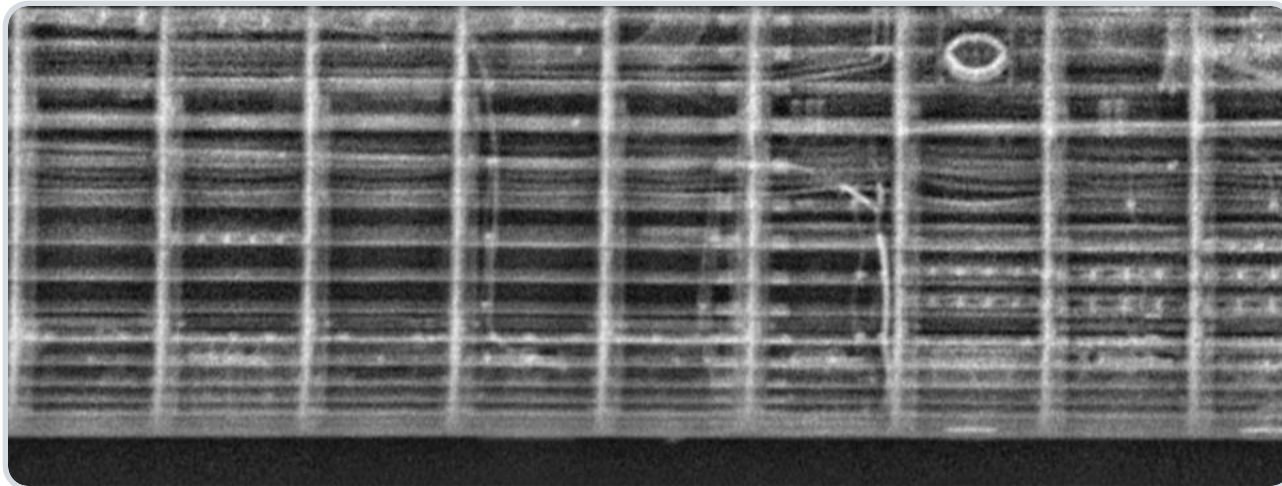
# General Aviation Scanner: Small Plane with Contraband

Images taken with system 7 ft from plane, 150 degree scans, 2 minutes per scan

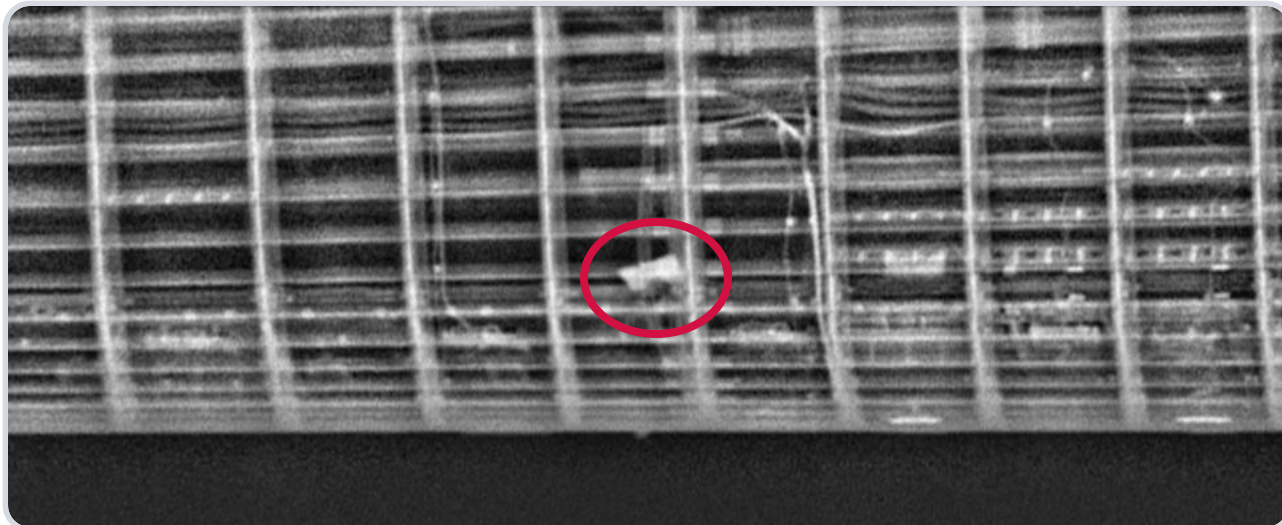




# Screening Large Aircraft Threat in Front Fuselage



**No threat**



**2 lbs of organic explosive simulant**

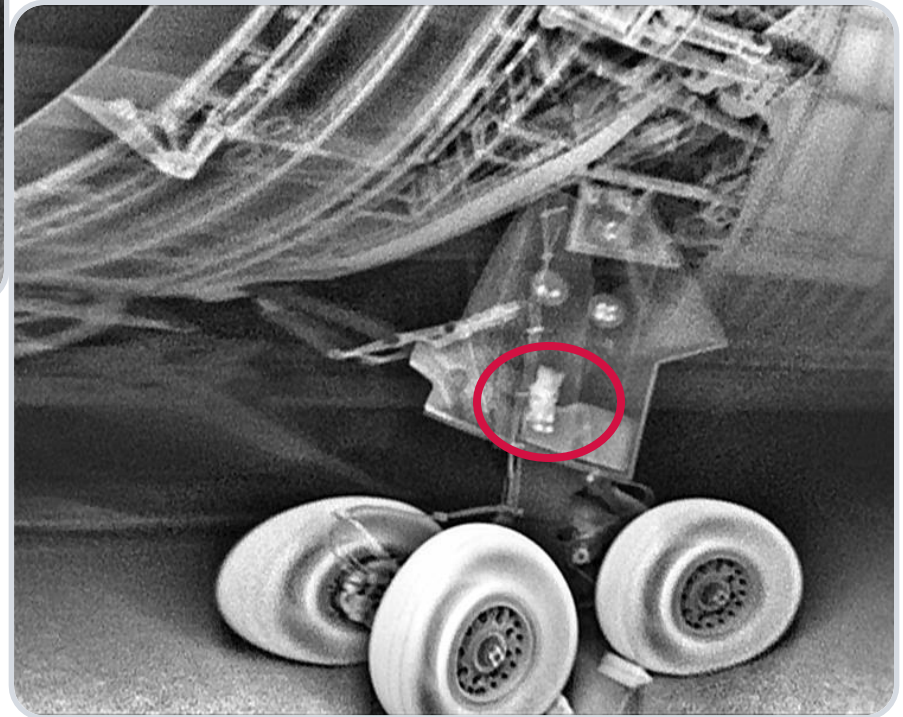
# Screening Large Aircraft

## Threat on Gear



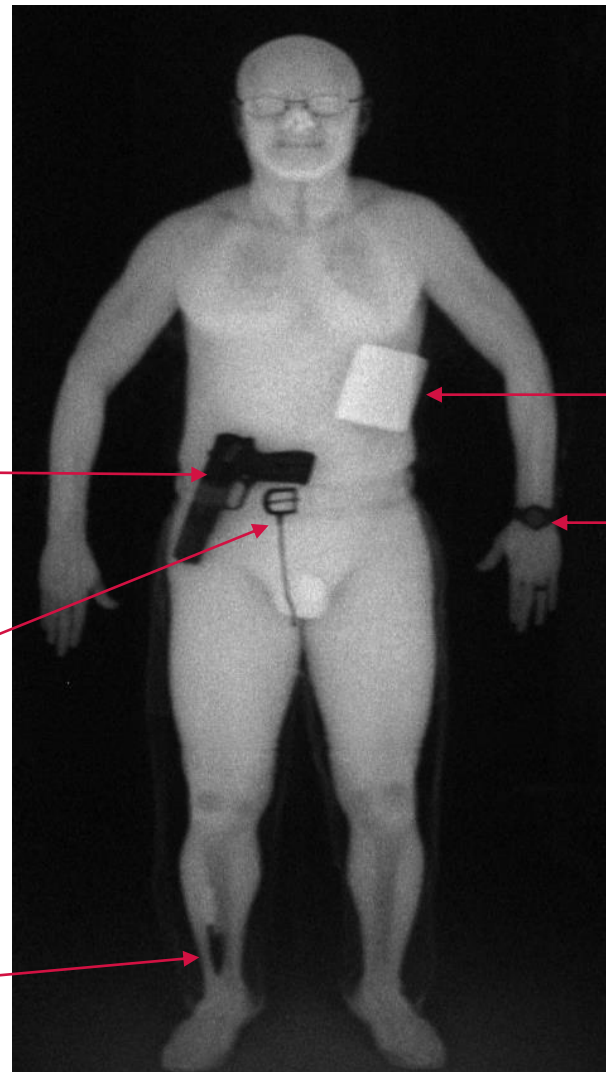
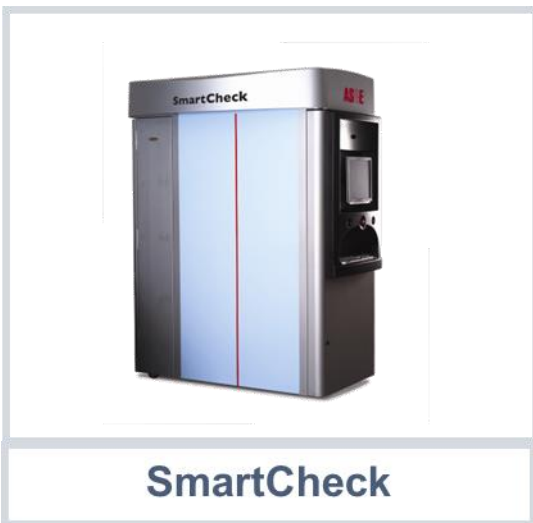
**No threat**

**2 lbs organic  
explosive simulant**



# Personnel Screening

- Image of a person with multiple threats (taken with AS&E's SmartCheck)



**Explosives**

**Gun**

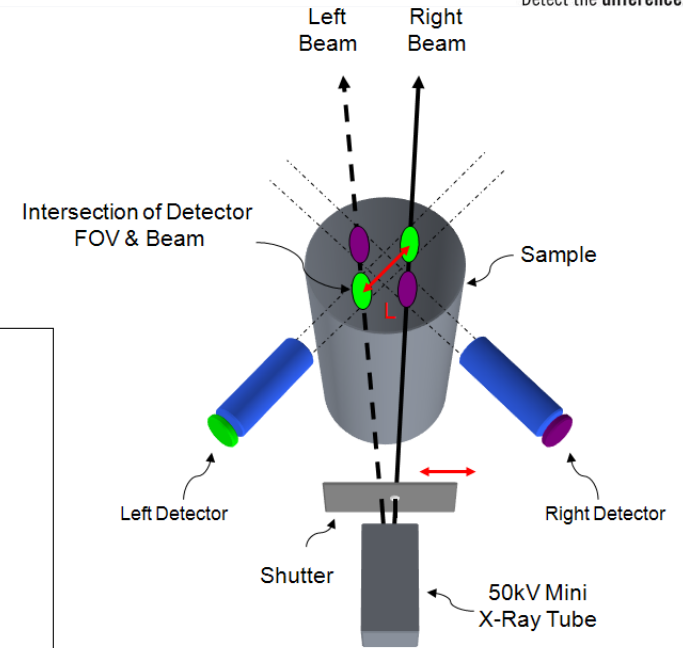
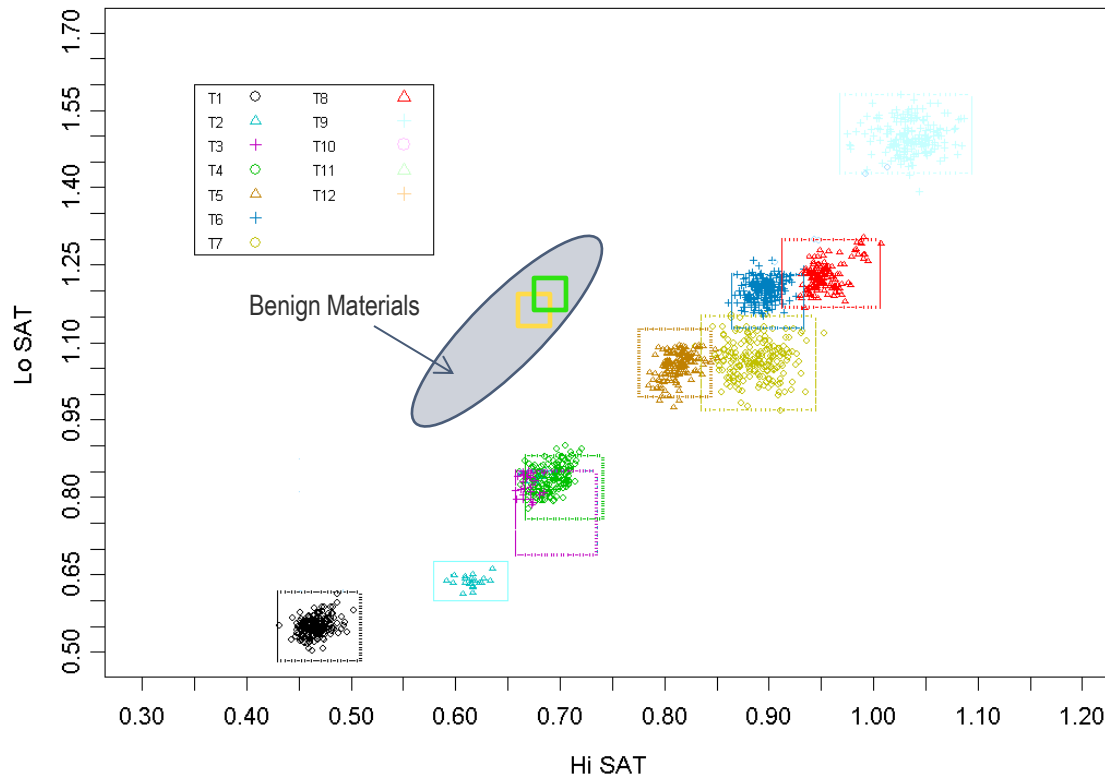
**Watch**

**Belt buckle and zipper**

**Ceramic Knife**

# Scatter Attenuation Tomography (SAT)

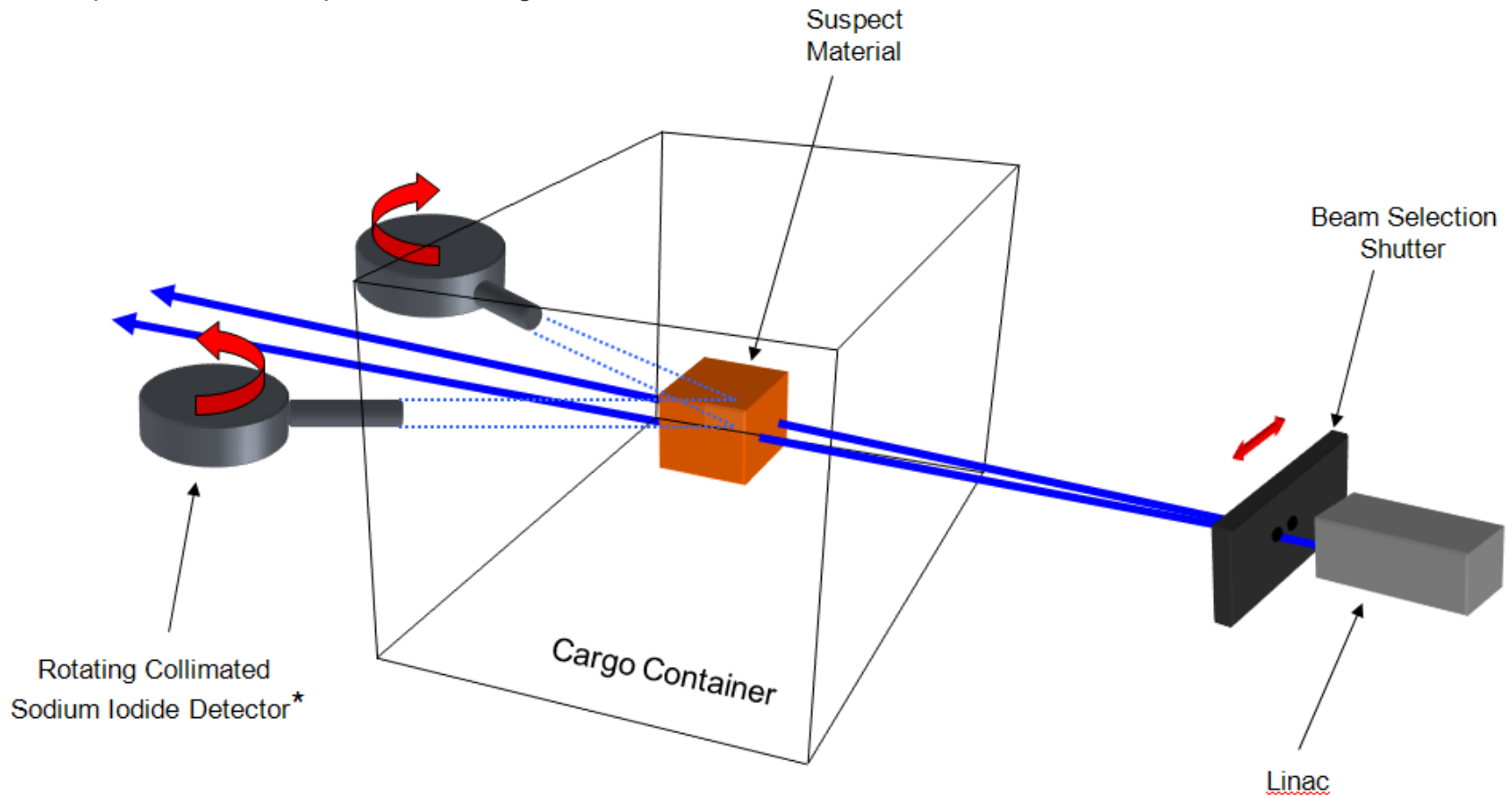
Measures the attenuation length of scattered radiation in the material being tested





# SAT Can Scale to Larger Cargo Sizes

Concept for Level 2 Inspection of Cargo



\*Rotation Angle of detectors selects depth of object being interrogated

# Limitations of the Method

- **Backscatter X-ray limitations**

- Difficult to penetrate optically dense cargo → limited penetration compared to transmission X-ray imaging
- Highlights organic materials but cannot distinguish between explosives and other high density benign organics
- Typically lower spatial resolution than transmission X-ray

- **Mitigation techniques**

- Combine with other scan method (e.g. X-ray transmission)
- Multiple views to increase cargo coverage

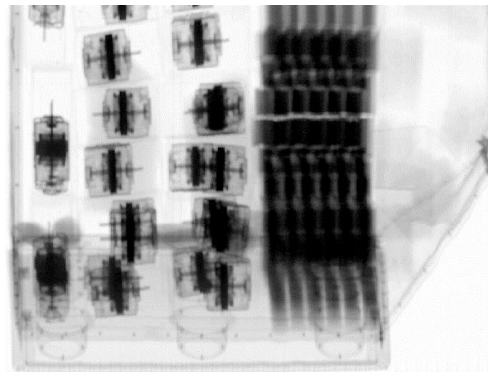
- **Optical density is a problem for transmission X-ray imaging too**

- Palletized cargo and ULDs are optically dense → higher energy necessary → lower Zeff resolution

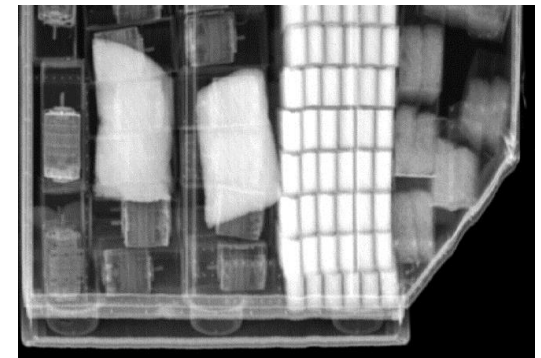
# Conclusions

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*Transmission Image*



*Backscatter Image*