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Enhancing Threat Detection: Tailoring X-ray systems with simulations to meet customized security needs

Mark Procter, Ph.D.
Vice President,
Cargo Science and Technology

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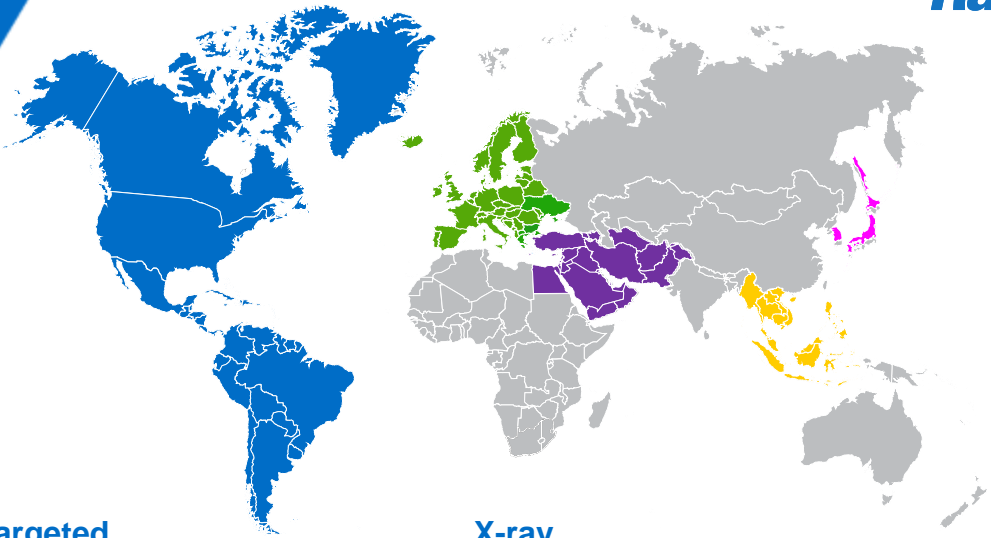
*Breaking Boundaries in Detection Technology:
Leveraging Innovation to Enhance Customs Control Efficiencies*



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Varied Trends in Global Performance Specifications



- There is a wide range of image performance requirements, standards and threat detection needs around the globe
- Some performance requirements can translate to complex solutions, BUT...
- Early discussions focused on **detection and operational requirements** rather than specifications can often result in more effective, less costly solutions

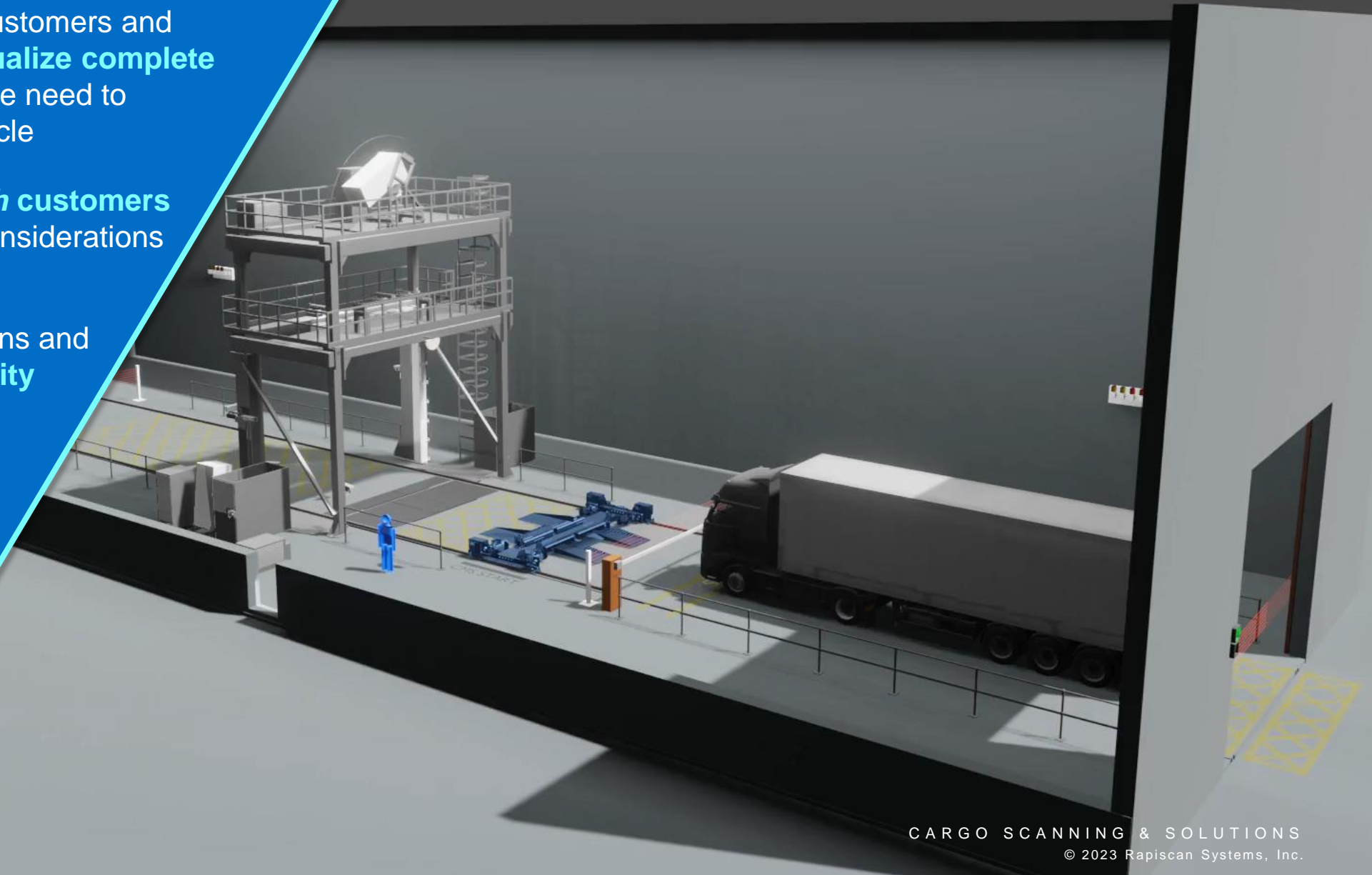
Standards	Targeted Ai Tools	Penetration	X-ray Imaging	Platform	Resolution	Occupied Scanning
ANSI	Empty Container	330	TX BX	Drive-Through Portals HE & LE	6	✓
ANSI/IEC	Cigarettes	330	TX → BX	Mobiles/Trailers (Gantry Mode) Rail Scanners	4	✗
Customs Specific	None	400	TX	Dual-View HE	5	✗
ANSI/Customs Specific	High Density	350	TX BX	HE/LE Gantries	3	✗
Customs Specific in Isolation	Cigarettes	330	TX BX	Drive-Through Portals	3	✓

System Operation

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- Game Engine tools allow customers and equipment providers to **visualize complete system** solutions without the need to build the first-of-its-type article
- Systems are **designed with customers** to ensure all deployment considerations are addressed
- Correct system configurations and CONOPs can drive **simplicity** in operation, **maximising performance**, throughput, and availability



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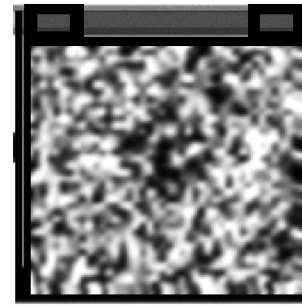
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Adding in the Physics

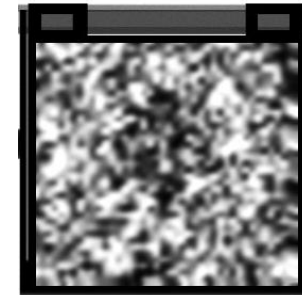
- Use of “Raycast” Physics functions that projects a Ray into the scene. Similar to Monte Carlo models, information on material “hits” can be stored and examined.
- Still emphasises the need for **X-ray domain expertise** in system design and configuration
- However, we add in only the physics needed for the task at hand
 - ⊗ X-ray source spectrum
 - ⊗ X-ray attenuation properties
 - ⊗ Detector response characteristics
 - ⊗ Material properties
 - ⊗ Image processing pipeline
 - ⊗ Noise characteristics
- **AND... we lower the barrier to entry**, by moving the resource bottleneck to object modelling and scene creation

```
# Draw smooth trajectories at end of event, showing trajectories  
# as markers 2 pixels wide:  
/vis/scene/add/trajectories smooth  
/vis/modeling/trajectories/create/drawByCharge  
/vis/modeling/trajectories/drawByCharge-0/default/setD  
/vis/modeling/trajectories/drawByCharge-0/default/set  
# (if too many tracks cause core dump => /tracking/s  
#  
# Draw hits at end of event:  
#/vis/scene/add/hits  
#  
# To draw only gammas:  
#/vis/filtering/trajectories/create/particleFilter  
#/vis/filtering/trajectories/particleFilter-0/ad  
#  
# To invert the above, drawing all particles ex  
# keep the above two lines but also add:  
#/vis/filtering/trajectories/particleFilter-0/  
#  
# Many other options are available with /vis/m  
# For example, to select colour by particle ID  
#/vis/modeling/trajectories/create/drawByPart
```

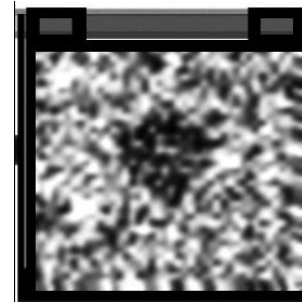
Simulating X-ray Images



1:1 Sampling



2:1 Sampling



3:1 Sampling

Interactive Array Simulator

Matching the scanning CONOPs for scan speed, X-ray source pulse frequency allows for generation of realistic image data. Can inform end-users on **expected image projection, quality and data rates**

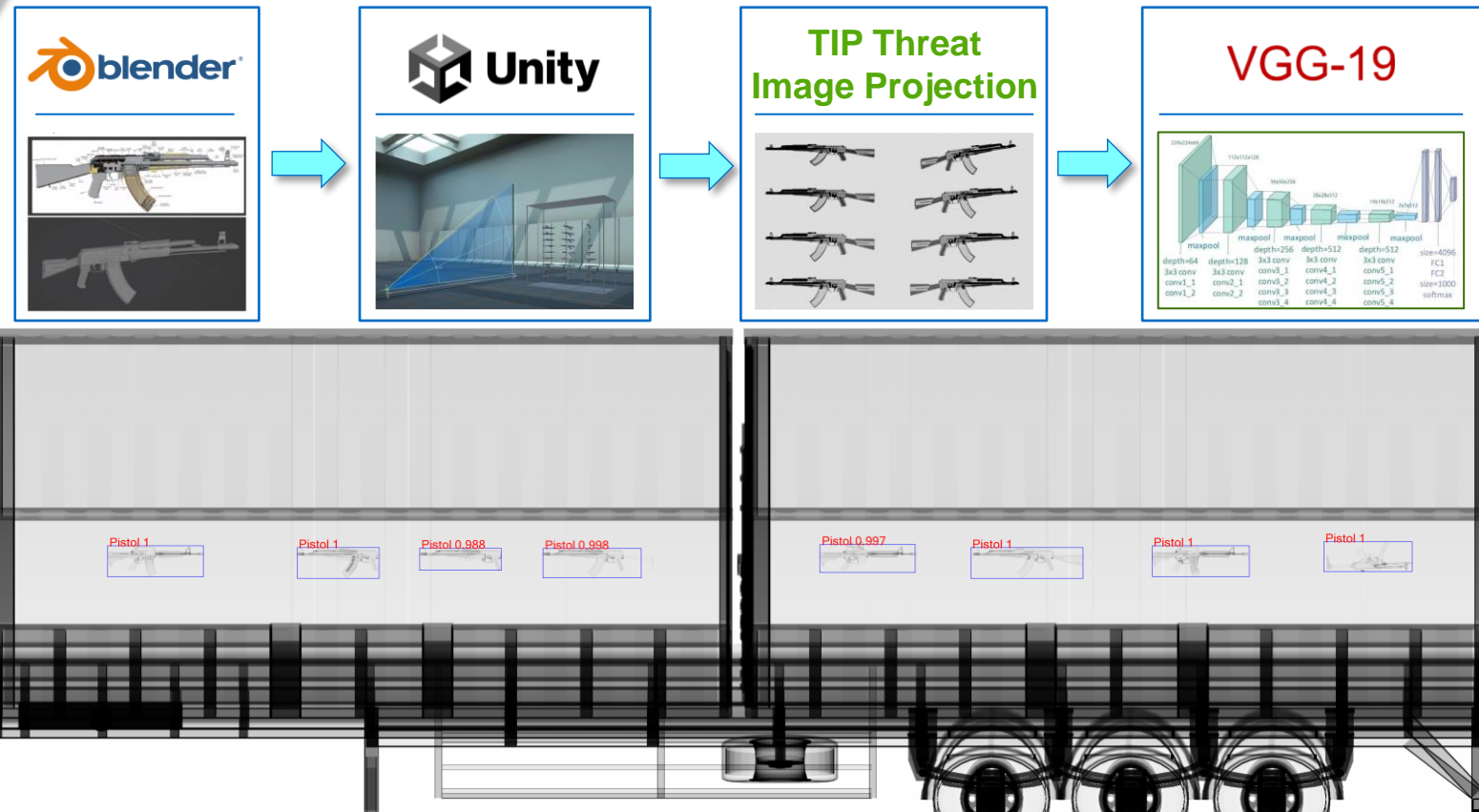
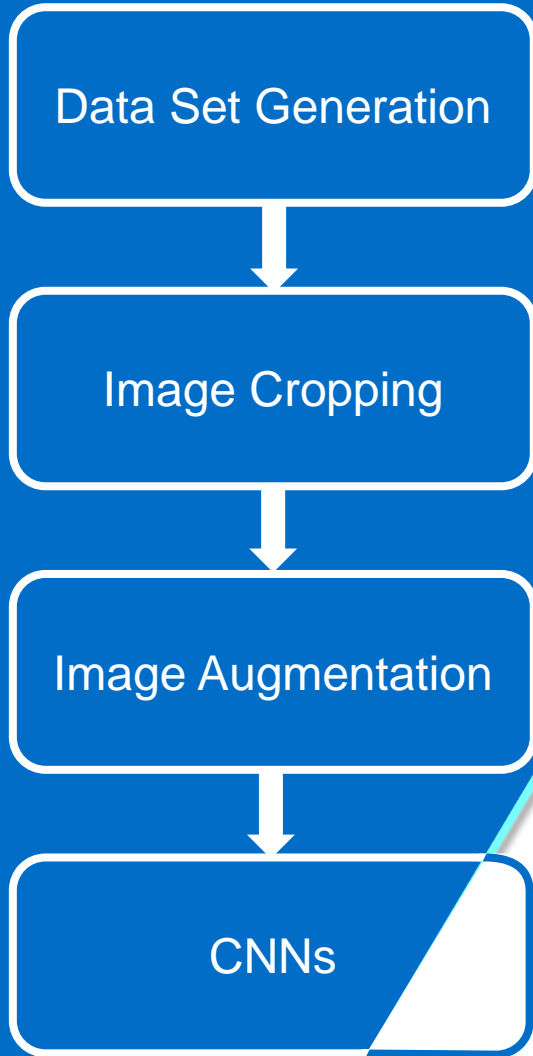
Incorporation of relevant physics allows performance metrics to be examined for different data capture routines

Dual-energy information can even **highlight material classification capabilities** and limitations

Valuable tool for spec'ing system designs, training operators and **exploring low-prevalence commodities or threats...**

Synthetic AI Data Generation

Overcoming low prevalence, data rights restrictions, commodity and transport variations in a scalable fashion



Thank You



UK Operations
Prospect Way, Victoria Business Park
Biddulph, Stoke-on-Trent ST8 7PL
United Kingdom

US Operations
829 Middlesex Turnpike
Billerica, MA 01821
USA

sales@as-e.com
sales@rapiscansystems.com
service@as-e.com

+1.978.262.8700 | 1.800.225.1608

www.rapiscan-ase.com