

A Multi-energy Stationary Gantry CT with XRD

Dan Strellis ADSA20 May 16, 2019

with Eric Miller and James Webber, Tufts University

This research was funded in part by the U.S. Department of Homeland Security, Science and Technology Directorate through contract 70-RSAT-18-C-B00000047

ONE COMPANY, TOTAL SECURITY



SO WHAT, WHO CARES?

- TSA requirements for screening accessible property at speed of the passenger are very challenging for existing technology
- Will require more precise and additional measurements
- Developing a 60 cm x 40 cm tunnel multi-energy stationary gantry CT system with a tightly integrated x-ray diffraction module.
- Embracing innovation, collaboration, and multi-measurement data fusion
- Taking a creative approach to development targeting multiple markets and receiving investment from them
- Goals: improve material discrimination, reduce false alarm rates, reduce power/weight/size, and reduce noise compared to offerings available today



START WITH RTT

- Baseline is the RTT hold baggage screening product
 - Stationary gantry CT
 - Experienced team
 - Distributed x-ray sources in one x-ray tube
 - Single energy detectors
 - 500 mm/s, ~1800 bags/hr
 - Automated explosives detection
 - Dangerous goods detection
 - ECAC Standard 3







UPGRADE TRANSMISSION DETECTORS

- Upgrade to multi-energy x-ray CT detectors using CZT technology
- 20 Mcps/mm2
- 8 keV FWHM
- Impact: Improved material discrimination





MODIFY SOURCE / TUNNEL FOR CHECKPOINT FOOTPRINT

- Modify tube and tunnel geometry
- 60 cm x 40 cm tunnel size
- Impact: Reduced size, weight, power, and noise









UPGRADE CT RECON

0.2



500

400

x (pixels)

300

100

200

600

700





- Establishing a multienergy CT reconstruction pipeline
- Impact: Improve user experience, improve material discrimination

ADD IN-LINE XRD AND COMPTON SCATTER

- Developing a new line of energy sensitive area detectors for XRD in house and with DHS S&T funding
- Exploring new method for XRD image reconstruction
- Use existing CT x-ray sources & detector collimation
- In-line XRD measurement
- Targeting 3 keV energy resolution
- Impact: improve material discrimination, reduce false alarm rate

Spectra from ¹⁰⁹Cd, ¹³³Ba, ⁵⁷Co and ^{99m}Tc



An OSI Systems Company



CREATIVE DEVELOPMENT APPROACH

- Internal R&D investment
- BAA 17-03 Support
- Leverage investment from a non-security partners
- Collaborate with university partners ALERT COE
 - Focused on transition of ALERT technologies to Rapiscan
 - Analytical and Monte-Carlo models for Bragg (coherent) and Compton (incoherent scatter) processes in RTT geometry
 - Efficient image formation and machine learning fusing Compton scatter, Bragg scatter, and transmission data

Rapiscan Systems ALERT: TUFTS – RAPISCAN COLLABORATION AN OSI Systems Company





MEAT & LIVESTOCK AUSTRALIA



- MLA is a public authority providing R&D for the Australian red meat producers
- We are partnering with them to provide a small bore stationary gantry CT system to measure meat quality in high values cuts of lamb and beef
- Meat/bone/fat content and marbling





MPI AND DAWR



- Ministry of Primary Industries (New Zealand) and Department of Agriculture and Water Resources (Australia) are interested in detecting bio-security threats
- Developing software platform and algorithm techniques applicable to the DHS project

ONE COMPANY, TOTAL SECURITY



CONCLUSION

- Multi-energy Small Bore Stationary Gantry CT with in-line XRD
- Targeting TSA's mission needs: reduce false alarm rates, keep passengers moving, increase usability for operator
- Targeting multiple markets to spread investment to meet multiple missions (TSA, MLA, MPI)
- Expecting first prototype of CT in 2020, XRD module to follow