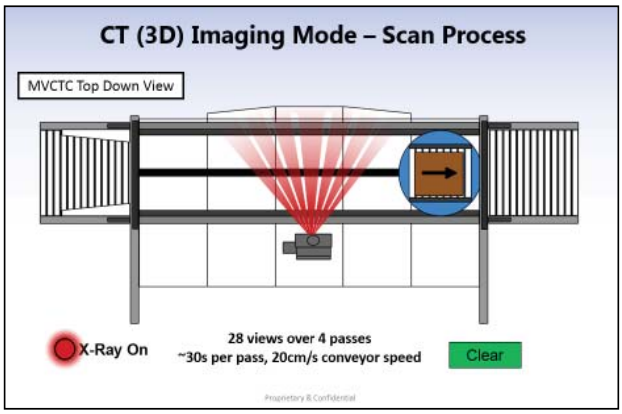
ALERT
AWARENESS AND LOCALIZATION OF EXPLOSIVES-RELATED THREATS

Development of a Multi-View CT Capable (MVCTC) Iterative Reconstruction Algorithm for Palletized Cargo

Screening Palletized Cargo for Threat Materials

A large quantity of items transported within the United States are shipped as palletized cargo with oversight from agencies including the Transportation Security Administration (TSA) and Customs and Border Protection (CBP). Astrophysics Inc. is developing a Multi-View CT Capable (MVCTC) X-ray scanner system that is designed to screen palletized cargo for threat or contraband materials and for illicit or hazardous substances sent both domestically and overseas. Astrophysics developed the MVCTC hardware and operating software with support from DHS Science and Technology Directorate under the Screening of Palletized Air Cargo Program. The unit acquires multi-view X-ray transmission images from a full 4' x 4' x 65" cargo pallet as a primary screening mode, and also uniquely reconstructs a 3D or CT X-ray image from the same data for 2nd level inspection or threat resolution.



The top down view of the MVCTC System's CT (3D) scan process for imaging palletized cargo using the ALERT-designed iterative reconstruction algorithms.

Astrophysics approached ALERT and asked the Center to develop an iterative reconstruction algorithm which would generate a 3D image of the pallet and its contents from the limited angle, limited number of view projection data acquired by the scanner.

Partnering for Ongoing Algorithm Development

Since 2013, the collaboration between Astrophysics and ALERT has resulted in multi-phase enhancements to the MVCTC system. Initially, ALERT created a base technical program to support Astrophysics' concept of operations and achieve the desired performance specifications by providing a mathematical instrument model and an iterative reconstruction algorithm. Following this, the team made improvements to the modelling, imaging quality, and system performance across a more extensive and realistic range of target and background materials and screening scenarios.

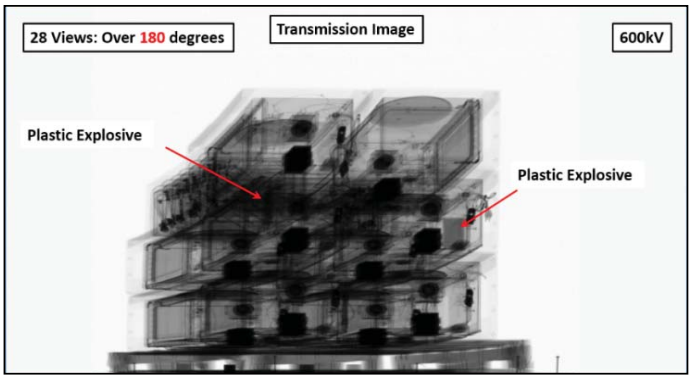
More recently, an MVCTC preliminary comparative evaluation was conducted by Astrophysics in conjunction with a lead customer using 45 diverse pallets, containing ~70 threat objects (such as plastic explosive simulant) at 600kV. The following table shows the assessed ability of a range of imaging modes to "see" a threat object using visual inspection only. The pallets were not restricted to homogeneous items, and contained a broad range of simulated threats in a realistic range of concealment scenarios.

Imaging Mode	Performance
28 View Transmission Plus CT Imaging	All threats observed
CT Imaging	High confidence- most threats observed
28 View Transmission	High confidence- most threats observed
Dual View	Moderate confidence – significant fraction of threats observed
Single View	Limited confidence – many threats not observed

New dual-energy CT decomposition algorithms have further improved MVCTC imaging using the multi-energy spectral X-ray information acquired by the MVCTC. This will allow display of "color" CT images analogous to those available in conventional orange-green-blue transmission imaging. A full software environment, source code and executable code were developed by ALERT for Astrophysics' use.

Status and Next Steps

The current MVCTC system provides a substantially improved imaging capability and significantly upgraded operational inspection and detection using a unique combination of integrated transmission and CT image inspection. Automated Threat Recognition algorithms are also currently under development to assist rapid and accurate pallet screening and resolution and manage screener workload in support of TSA air cargo screening applications and requirements. Work on improved dual-energy reconstruction is continuing along with methods and computer hardware to reduce reconstruction processing time and speed screening throughput. In addition, we expect the CT imaging methods developed will have important applications in other screening and inspection applications including baggage and package screening for TSA and CBP.



A 28 view transmission image of a pallet containing microwaves, gas burners, and hidden plastic explosives. Scan time is about 30 seconds.

To learn more about the partnership between Astrophysics and ALERT in the Development of a MVCTC Iterative Reconstruction Algorithm for Palletized Cargo, contact the ALERT COE at ***alert-info@neu.edu.***