

Evolution of X-Ray Security Systems

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Tombstone R&D

- Catastrophic events result in:
 - Increased R&D budgets
 - Deployment of existing technologies
(all wars are come-as-you-are parties)
 - Governmental reorganization
- As time passes:
 - R&D budgets decrease
 - Cost factors outweigh security issues
 - Turf battles create government gridlock

Mine & IED Warfare Events

- Russian wooden box mines impacts German armor in WW II
- Viet Cong IEDs result in >50% of U.S. casualties
- Iraqi IEDs

Mine & IED Detection

Top left: Neutron thermalization (Buck Rogers)

Top right: Dual-energy bicycle bomb detector

Bottom left: X-ray backscatter

Bottom right: X-ray backscatter van (AS&E)



Civil Aviation Events

- Hijackings to Cuba (1968 peak)
- LaGuardia bombing (1975)
- Air India (1985)
- PanAm 103 (1988)
- 9/11 (2001)

Response to: Cuban Hijackings

- Almost 400 hijackings & attempts between 1967 & 1976 (1968 peak)
- Checkpoint security mandated in 1972 (effective Jan. 5, 1973)
 - X-ray carry-on for guns & knives
 - Metal detectors for passengers

The Earliest X-Ray Security Scanners

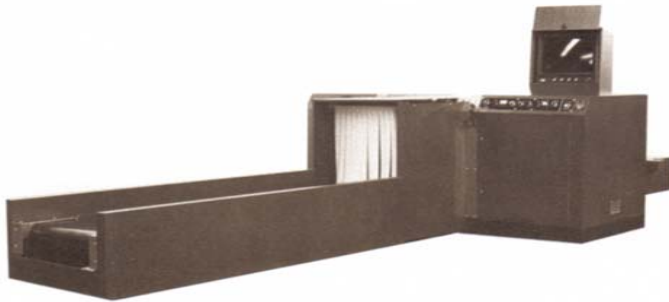
Fluoroscopes

- Produced by
 - Bendix
 - Philips
 - ScanRay
 - Others
- Direct view or TV
- No image storage, digital or otherwise



Early Fluoroscopic Scanner

SCANRAY
X-RAY INSPECTION SYSTEMS



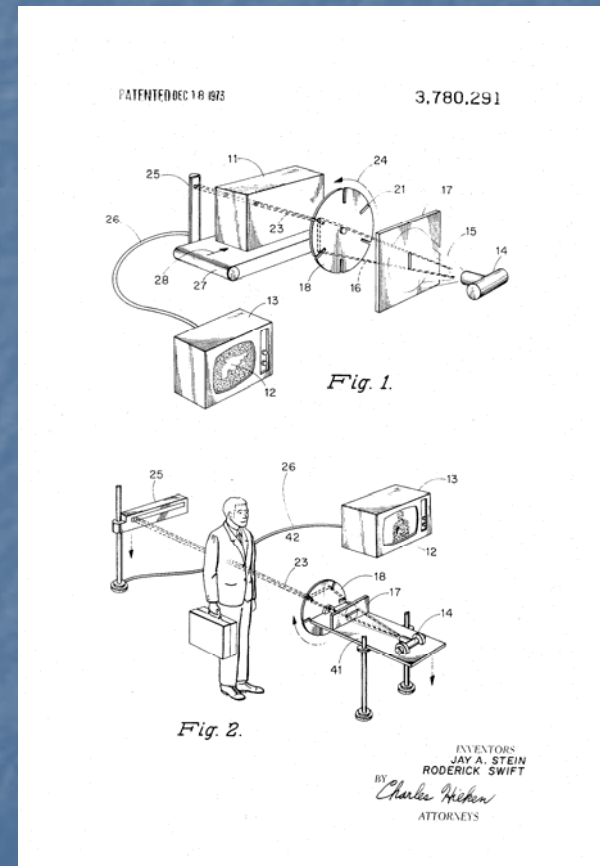
MARK IV

The Mark IV offers a special heavy duty conveyor and large capacity to easily handle heavy, bulky items such as airline checked baggage, shipping cartons, etc. A "high energy" button is provided on the control panel which increases the energy of the x-ray beam to give greater penetrating power when necessary. This unit can be equipped with a special biocular direct view display for direct viewing. It is also available with a large 17" TV monitor on which the contents of the inspected items are displayed. The Mark IV is ruggedly constructed for heavy duty service.

- Horizontal beam
- Fluorescent screen
- Image intensified TV
- No image storage
- 65kV, 0.25 mA
(90kV pulse mode)
- Lead-lined wooden cabinet

Evolution: Flying Spot

- AS&E patent
- Jay Stein
- No digital store in original
- Excelled in resolution, dynamic range, scatter rejection, low dose
- Reliability an issue



Evolution: Line Scan

- ScanRay
(Astrophysics) Patent
- Andy Kotowski
- Digital image store
- Low dose
- Low scatter
- Reliable

U.S. Patent Dec. 28, 1982 Sheet 2 of 6 4,366,382

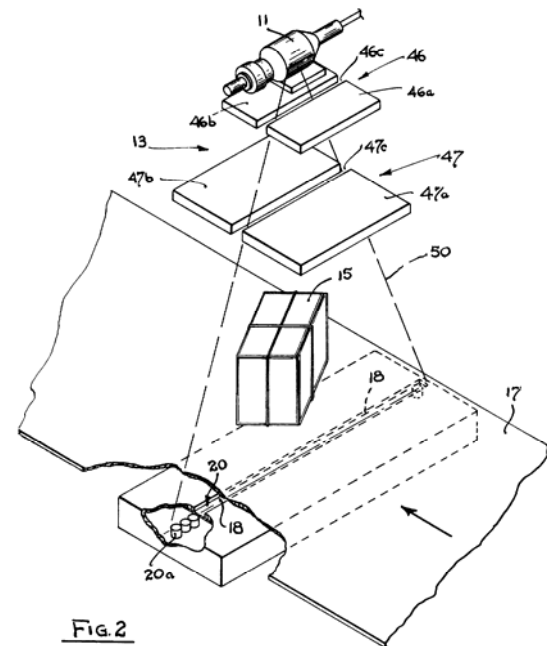


Fig. 2

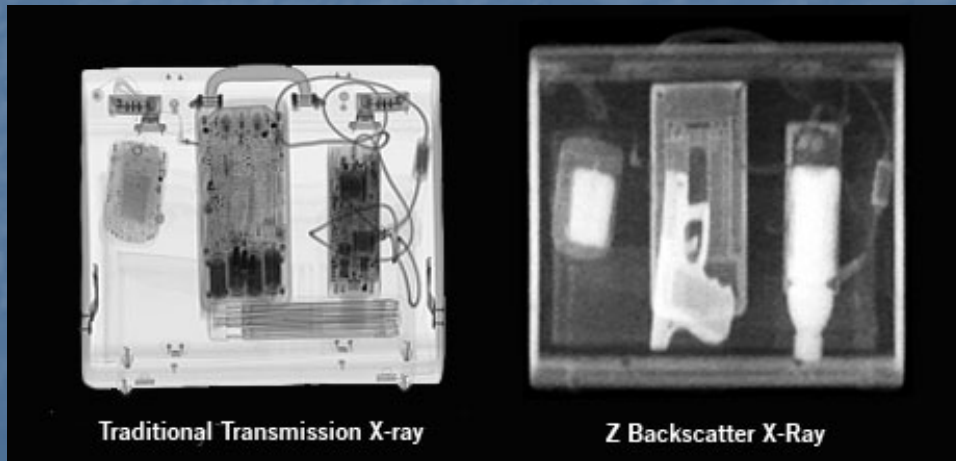
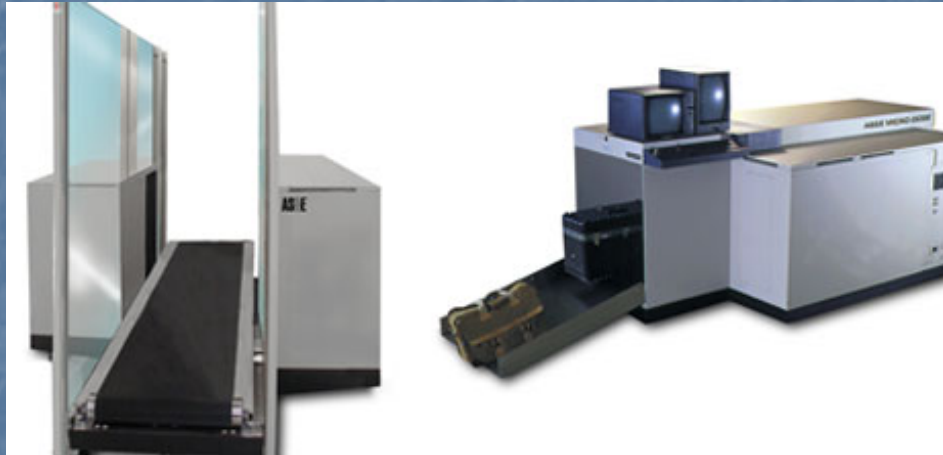
Response to: La Guardia Bombing (1975)

- R&D program established by FAA
- Three initiatives established by “Tiger Team”
 - Thermal neutron analysis (TNA) - Westinghouse
 - Nuclear magnetic resonance (NMR) – SwRI
 - Gamma transmission - Westinghouse
- No x-ray initiatives *per se*

Response to: Air India (1985)

- X-ray scanners transition from weapons detection to explosives detection
 - Dual energy
 - Backscatter

Backscatter & Dual-Energy



Traditional Transmission X-ray

Z Backscatter X-Ray



Response to: PanAm 103 (1988)

- TNA (SAIC) deployed
- Advanced Technology (AT) systems deployed
 - Automated explosives detection
 - Multiple-view x-ray
 - Single-view, dual-energy
- Explosives detection R&D of all types stepped up
- For x-ray, CT development funded (1992)

AT Systems Deployed after PanAm 103

Vivid VIS108

Astrophysics Z Scan



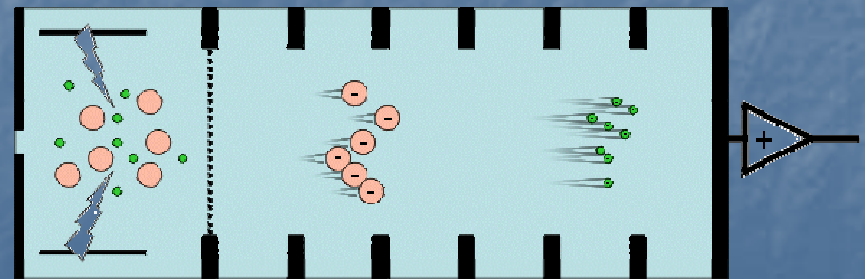
Response to: 9/11 (2001)

All technology fielded post-9/11 existed before 9/11

- For checked baggage:
 - CT-based EDS
 - IMS-based ETD
 - Return to AT?
- For carry-on
 - Threat Image Projection (TIP) added to dual-energy scanners, now called TRX
 - Multiple view
 - Return to AT?
- For passengers
 - Enhanced metal detectors
 - Trace portals
 - X-ray backscatter and mm-wave imaging
 - X-ray backscatter for casts

Explosives Trace Detection (ETD)

- Produced by GE & Smiths (formerly ITI & Barringer)
- ng sensitivity
- High specificity
- Labor-intensive
- High cost of consumables



Explosives Detection Systems (EDS)

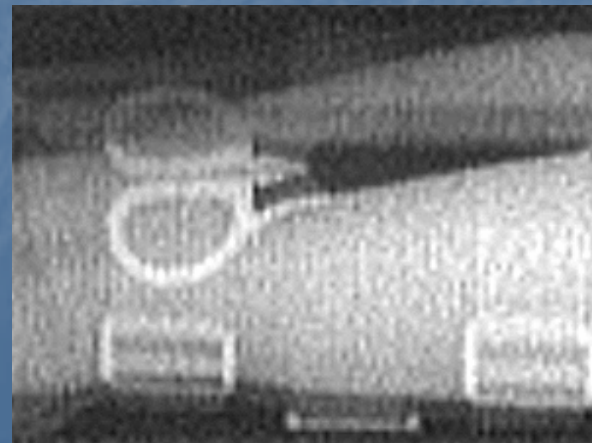
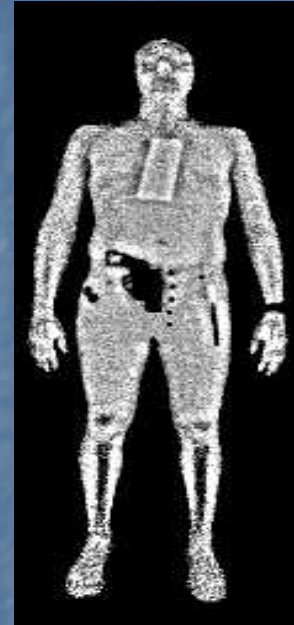


TRX Systems

Smiths, Rapiscan & L-3



X-Ray Backscatter for Passengers



Status

- We are still in the aftermath of 9/11, but cost factors now weigh heavily on what is deployed.
- New technology initiatives have had limited success thus far, but insufficient time has passed.
- Government continues to reorganize and struggles to establish meaningful performance criteria and R&D programs.