RESONANCE TECHNOLOGY
Novel Approach for Detection & Imaging of Explosives and Chemical Warfare Agents

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December, 2001

Objectives

Detection and Imaging of Explosives and Chemical Warfare Agents

Using Resonance Technology

Current Technologies & Deficiencies

- **Sniffers**

Sniffers are used for sampling particulates and vapor of explosives. A variety of techniques, e.g., ion mobility, mass spectroscopy, ECD, etc., are used for detection. These systems are operated under specific sampling guidelines optimized for specific applications.

Sniffers are not well suited for;
bulk inspection,
detection of explosives with low vapor pressure,
thoroughly sealed objects.

Current Technologies & Deficiencies

- **X-Rays**

<u>Soft (100-300keV)</u> x-rays used in either transmission, backscattering, dual-energy or CT modes monitor density or effective Z of the object.
X-Rays are non-specific to explosives,
suffer from high false alarm rate of 20% to 40%,
depend on material distribution within an object,
unsuitable for large objects.

<u>Hard (MeV)</u> x-rays, including Cs and Co sources, have higher penetration range and also measure density.
They are useful for manifest verification and inspection of empty containers.
Non specific,
low contrast,
high false alarm rate.

Current Technologies & Deficiencies

- **Nuclear Technology** ***(not deployed)***

  <u>Pulsed Fast Neutron Analysis (PFNA)</u> technology is element specific, provides 3-D images, high throughput, low false alarm rate and is suitable for large cargo.
  Produces large neutron fields,
  residual activation with potential health hazard,
  Expensive ~$10M per unit.

  <u>Thermal Neutron Activation (TNA)</u> is element specific.
  Depends on the bulk sample content,
  uses large neutron fields,
  residual activation with potential health hazard,
  unsuitable for large cargo.

Proposed Technology

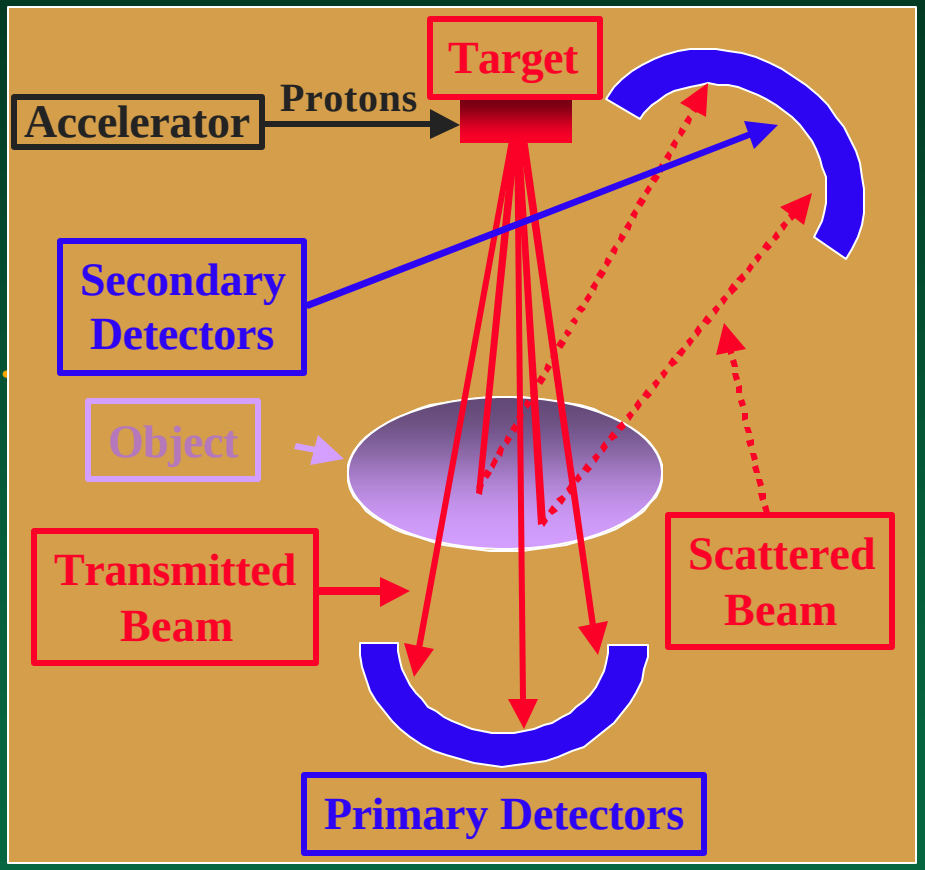
Resonance Technology (RT) overcomes many of the deficiencies of the current systems in use. The key factors being;

- **Uses hard (9MeV) x-rays – high penetration range.**
- **Enables elemental interrogation, e.g.,N, Cl – specificity to explosives.**
- **Suitable for interrogation of small and large cargos.**
- **No residual activation – no residual health hazard.**
- **High throughput with low false alarm rate – as compared to x-ray systems.**
- **Single unit can feed in series or in parallel. several inspection stations – unique feature to RT.**

Principle of the Resonance Technology

A low energy proton beam hits a dedicated target and produces resonance gamma rays. These interact resonantly with N or Cl encountered in the explosive.

Monitoring the transmitted and the scattered beams, with the primary and secondary detectors, respectively, allows analysis and imaging of the elements of interest.



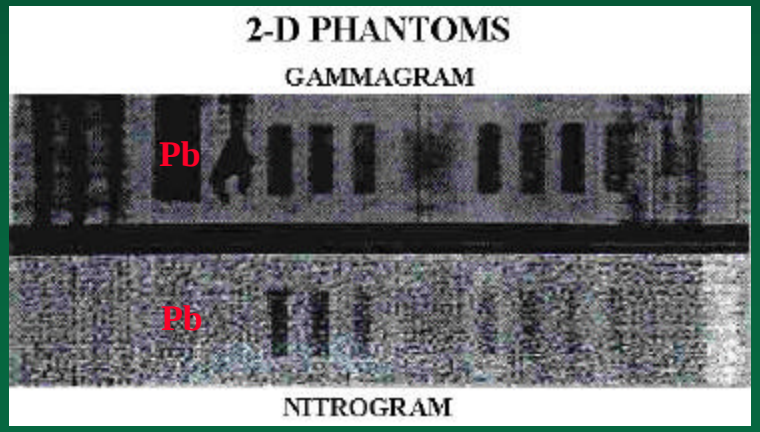
RT Proof-of-Principle

Proof-of-Principle Has Been Demonstrated Using Resonance Detectors ***(Soreq NRC)***

Test set up using explosive simulants (nitrogenous material) and other objects

Total density image

Nitrogen density image highlights explosive simulants and makes 2" lead brick transparent



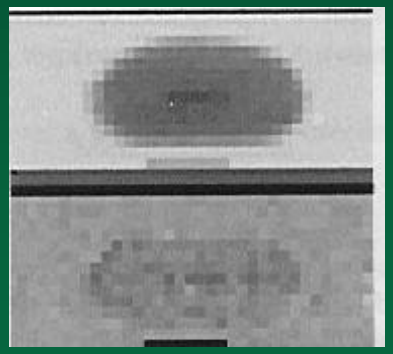
Experiments with RT

Sample material containing on average 2.7% N by weight.

Using Experimental Prototype

Gammagram

Nitrogram

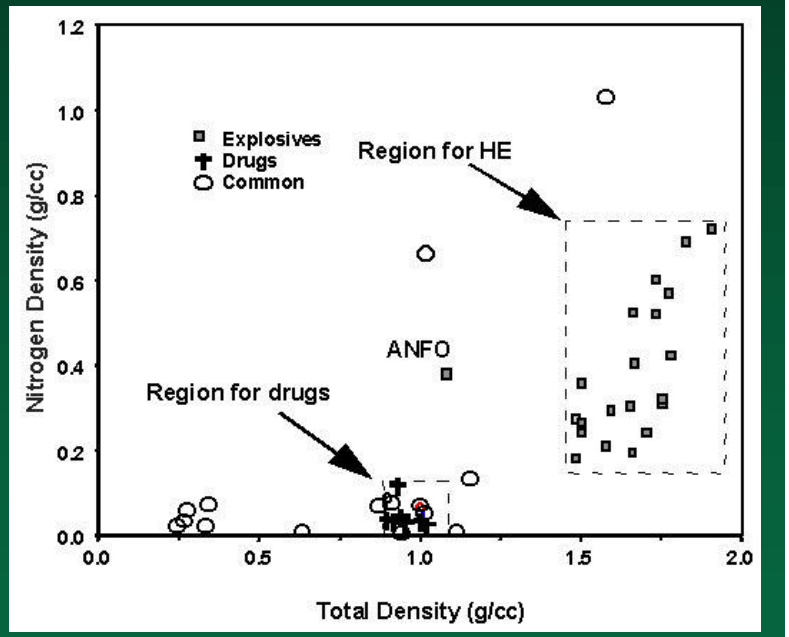


By comparison explosives contain between 10% and 30% N by weight.

Experiments with RT

A Distinct Advantage of Resonance Technology

Simultaneous registration of the total density and the nitrogen density separates the explosives from other common materials.
This two dimensional matrix allows for fully automatic identification of explosives.



Advantages of the proposed RT

- High Detection Probability (>90%)
- Potentially Low False Alarm Rate (<5%)
- High Throughput (1600 bags/hr, 24LD-3/hr)/station
- Insensitive to Cargo Type (break bulk, palatalized…)
- Specific Explosive Signature (nitrogen/chlorine)
- Single Source Can Feed Multiple Inspection Stations (in parallel or in time share modes)
- Suitable for Inspection of Postal Parcels Up To Large Vehicles or Ship Containers
- Explosives 3-D Imaging Capability
- No Residual Activity
- Fully Automated Decision Making

RT Users for Detection of Explosives

Detection of Explosives

Department of Transportation (DoT)
- FAA – Airport Security
- Explosives Detection in Cargo/Containers
- Checked baggage inspection
- Scanning trucks/vehicles
- Railroad Security

Force Protection (DoD)
- Military Bases
- Counter-terrorism
- Explosives Detection in Vehicles

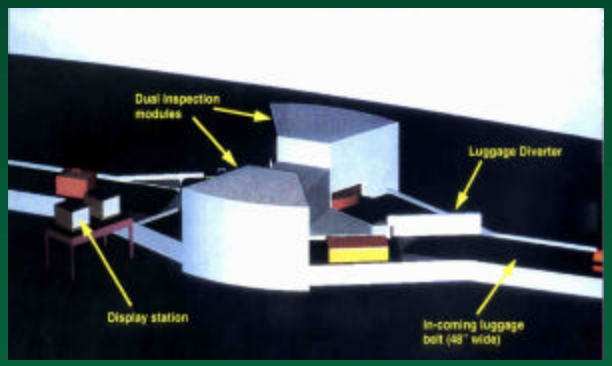
Warhead/Rocket QC (DoD)
- Crack & Void Detection
- Mixture Quality
- 24% Rejection / Shelf Life

Environmental Cleanup (DoD)
- Unexploded Ordnance Detection
- Mine Field Clearance

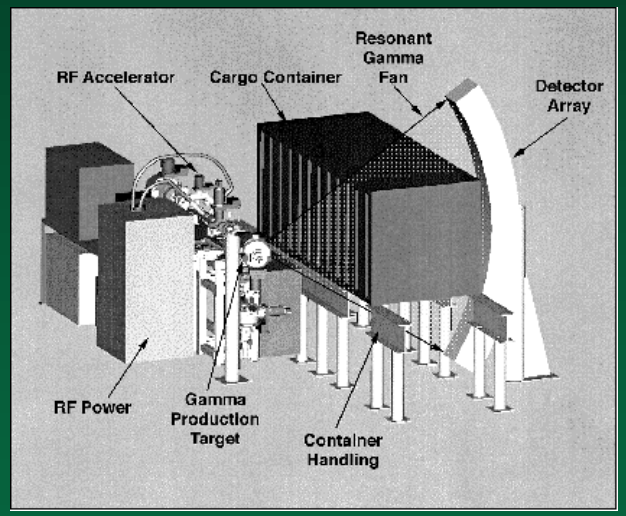
US Customs
- Border Control
- Seaports
- Explosives / Drug Detection in Large Containers

RT Uses

Resonance Technology applied for small and large cargo inspection



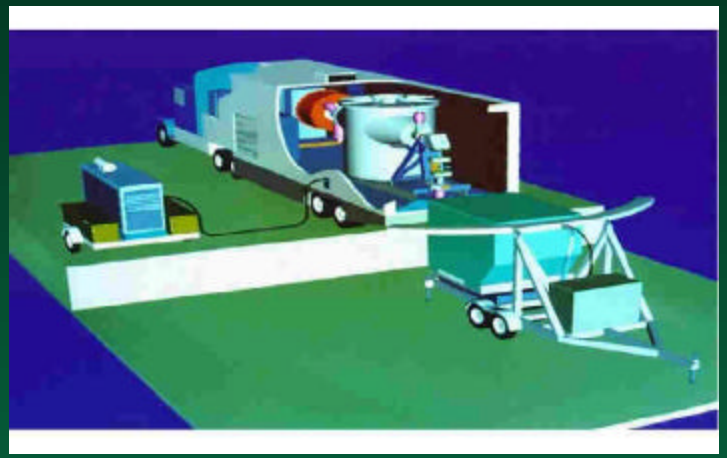
A configuration of a system in an airport feeding simultaneously two inspection stations for bags.



A possible configuration for scanning large containers

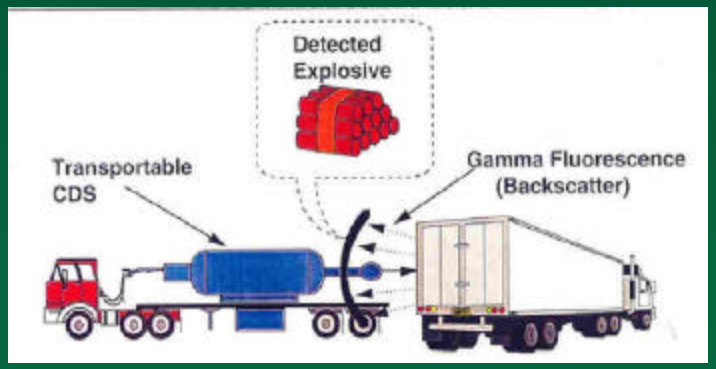
RT Uses

Alternative implementations of the Resonance Technology

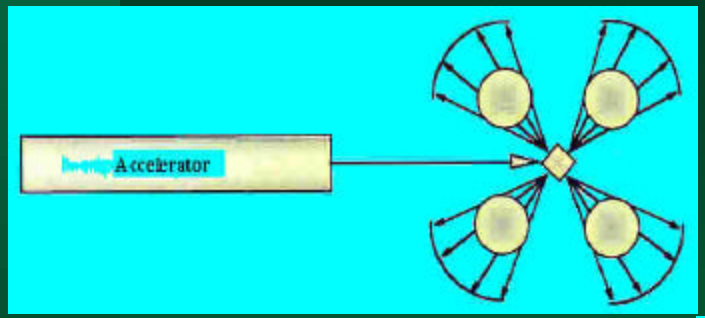


Can be engineered into a transportable, readily deployable system

Stand off use of the system in a fluorescence (backscattering) mode

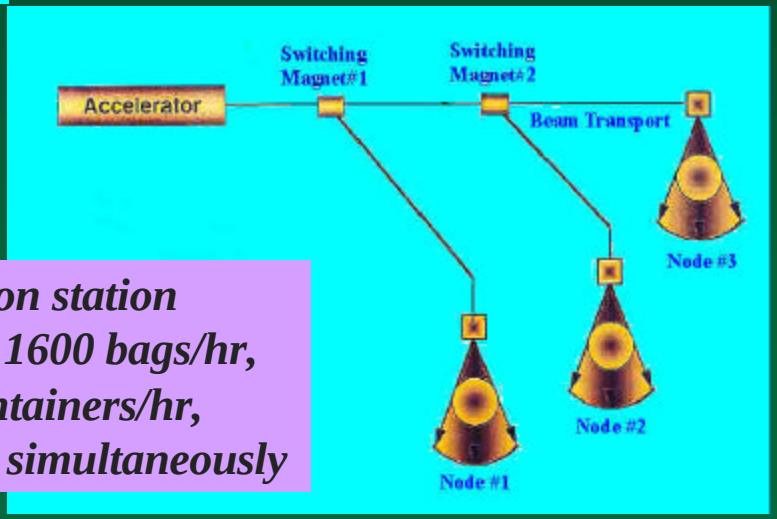


RT Alternative Configurations



Single system feeds simultaneously four inspection stations.

Single system feeds alternatively three inspection stations.



Each detection station can process 1600 bags/hr, 24 LD-3 containers/hr, 4 conveyors simultaneously

Near Term Deliverables

1. **Complete BNL Development and Test Facility**

   - Finalize installation and commission of the accelerator
     - Refurbish rotating target
       - Construct new resonance detectors
         - System integration and testing

   Ready in one year or less

2. **Starting Testing of User Specified Integrated System for Explosive Detection.**

RT Summary

1. **Proof-of-principle of an advanced Resonance Technology (RT) approach for explosive detection and imaging has been demonstrated.**
2. **The proposed RT fills many serious deficiencies incurred by the current x-ray scanners and other systems in use.**
3. **Extensive expertise at BNL in the areas of particle accelerators, x-ray detectors and systems integration provide high probability for success.**
4. **Main components are readily available and are being installed.**
5. **Short delivery time (~1year) of a test facility.**