Use of Gamma Resonance Imaging for Detection of Explosives

L. Wielopolski, J. Alessi¹, P. Thieberger¹, J. Brondo², J. Sredniawski³, and D. Vartcky⁴, **Brookhaven National Laboratory Environmental Sciences Department**, ¹Collider Accelerator Department, Upton, NY 11973

²Scientific Innovations Inc. ³Advanced Energy Systems Inc. ⁴Nuclear Research Center Nahal Soreq, Israel.

BROOKHAVEN

POC – Lucian Wielopolski, E-mail: lwielo@bnl.gov

Objective

To implement a novel and efficient approach for detection and localization of explosives in small packages, luggage and large cargo containers. The method takes advantage of Gamma Nuclear Resonance Absorption (GNRA). This is an element specific interaction of highly penetrating gamma radiation with matter. The method is also applicable for detection of radiation dispersive devices and nuclear bombs, both of which contain explosives for their operation.

Majority of explosives are distinguished from other common materials by higher nitrogen and total densities. Thus simultaneous determination of these two will identify explosives uniquely as shown in Figure 1.

A Gamma Resonance System

A system based on gamma resonance consists of a proton accelerator with a <u>suitable target material</u> upon which impinging protons produce a resonance gamma beam via a proton resonance (p, γ) reaction. The resonance gamma radiation interrogating an object is detected by specific resonance detectors. .The system can be utilized in a transmission mode, like in a CT scanner, or in a scattering stand-off mode.

Results of a Proof-of-Principle





projection of the total density.

Lower image is the projection

of the nitrogen density

Interrogation for explosives of a LD-3 air cargo container using resonance detectors performed at Los Alamos National Lab.





Imaging of nitrogenous and non-nitrogenous object performed at **Birmingham University.**

A lead brick and a wrench are transparent to resonance gamma rays.

Status

- 1. High intensity accelerator designed by TRIUMF/Northrop Grumman, to operate at 10 mA achieved ~2 mA at 1.8 MeV.
- 2. Resonance detectors for nitrogen have been designed and tested.
- Accelerator injector assembly is now installed at BNL. 3.
- Further development of the accelerator, detectors, electronics and 4. system integration could be performed at BNL, with appropriate funding.



High intensity proton accelerator at Northrop Grumman prior to transfer to BNL



Installation of the accelerator injector at BNL, future site for system integration and testing.





Figure 1. A two dimensional plot of explosives and few common material containing nitrogen

Total Density (g/cc)

Artistic Views of Future Systems





A possible configuration for

scanning large containers

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

Alternative deployment of a mobile and a stand-off systems



Simultaneous use of multiple ramps for cargo or convever belts will increase the throughput. Forty foot container can be interrogated in about 3 to 4 minutes. Stacked containers will double the capacity. (Extrapolated from experiments)



Summary of Gamma Resonance System

- Unambiguously identifies explosives with fully automated algorithms
- Elemental imaging of nitrogen for explosive localization
- Uses highly penetrating 9.17 MeV gamma ray energy
- Simultaneous inspection at multiple stations
- Batch processing instead of individual items
- Low false positive alarm rate; about 1% or less possible
- High hourly throughputs:~1600 bags, ~24 LD-3 or 40' containers
- No induced residual activation of an interrogated object
- A deployable commercial system deliverable in ~3 years at a cost of ~4 M\$
 - A full-scale demonstration system feasible at BNL within a year