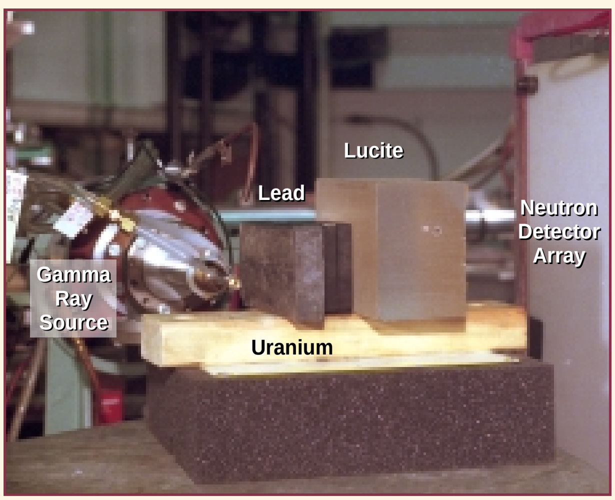
Nabbing Nuclear Smugglers

Challenge

Terrorists may try to smuggle nuclear materials across national borders or past nuclear facility security systems. This threat could be substantially reduced, however, by development of an effective, transportable, and affordable inspection system that could be easily deployed at such critical locations as border crossings and security checkpoints at nuclear facilities.

Argonne's Solution

Argonne researchers are developing such a system. Called FIGARO (Fissile Interrogation using Gamma Rays from Oxygen), it is designed to direct high-energy gamma rays into packages, luggage, and shipping crates to detect the presence of smuggled nuclear materials (Figure 1). FIGARO can ferret out nuclear materials no matter what size, shape, or chemical form they come in — even if they are hidden inside heavily shielded containers. Because gamma-ray photons serve as the probe, inspected items do not pick up any residual radioactivity as a result of the detection process. By the same token, when the system is turned off, radioactivity ceases to be a concern in handling and transporting the system. FIGARO is compact enough to be transported by small truck or airplane for rapid deployment in response to changing threats. A single accelerator could serve multiple checkpoint portals at a particular location.



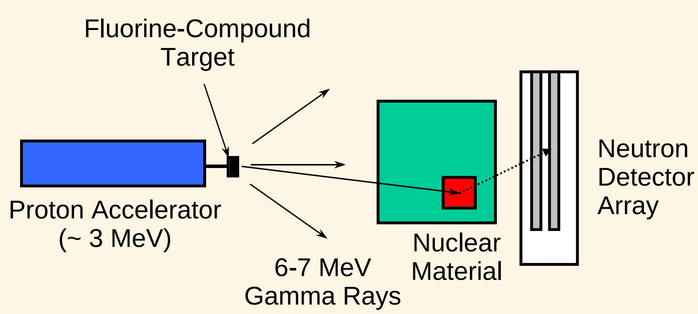


Figure 1. Argonne's FIGARO system directs high-energy gamma rays into packages, luggage, and shipping crates to detect the presence of smuggled nuclear materials.

Approach

FIGARO accelerates protons to energies of 2–3 MeV. The protons then strike a sulfur hexafluoride target, inducing nuclear reactions that release nearly mono-energetic, high-energy (6–7 MeV) gamma rays. The gamma rays, which pass through ordinary materials almost as if they were not there, trigger nuclear reactions when they encounter nuclear materials. These nuclear reactions release neutrons, which also easily pass through dense materials and are detected by the system's neutron counter (Figure 2). FIGARO can provide very effective detection of all nuclear materials because it makes highly efficient use of both the accelerator-produced gamma rays and the induced telltale neutrons.

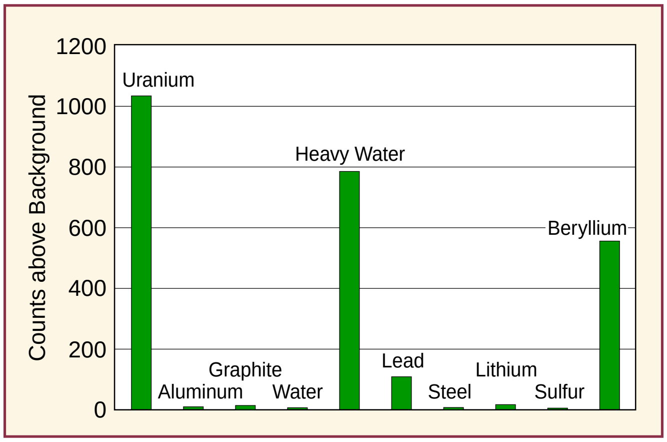


Figure 2. High neutron counts reveal nuclear materials.

Accomplishments

Experiments have indicated that FIGARO can detect nuclear materials in quantities as small as 100 grams in about one minute. Experiments have also shown that FIGARO is highly resistant to gamma-ray and neutron shielding countermeasures. Copper and lead gamma-ray shields were tested along with neutron shields of polyethylene, borated polyethylene, Lucite, and borax. Detectable neutron counts were found even when one inch of lead was placed in front of a sample of depleted uranium and three inches of Lucite was placed behind.

A special high-current gas cell was designed as a container for the sulfur hexafluoride target material. The cell achieved stable operation for proton beam currents of up to 8 microamperes, and it should be capable of operating at currents of up to 100 microamperes. Measurements of gamma-ray yields have shown that it should be possible to build the system's proton accelerator out of commercially available components. The same is also expected to be true of the system's neutron detector.

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