Supersenzor

Directed Fast Neutron System for Landmine Confirmation

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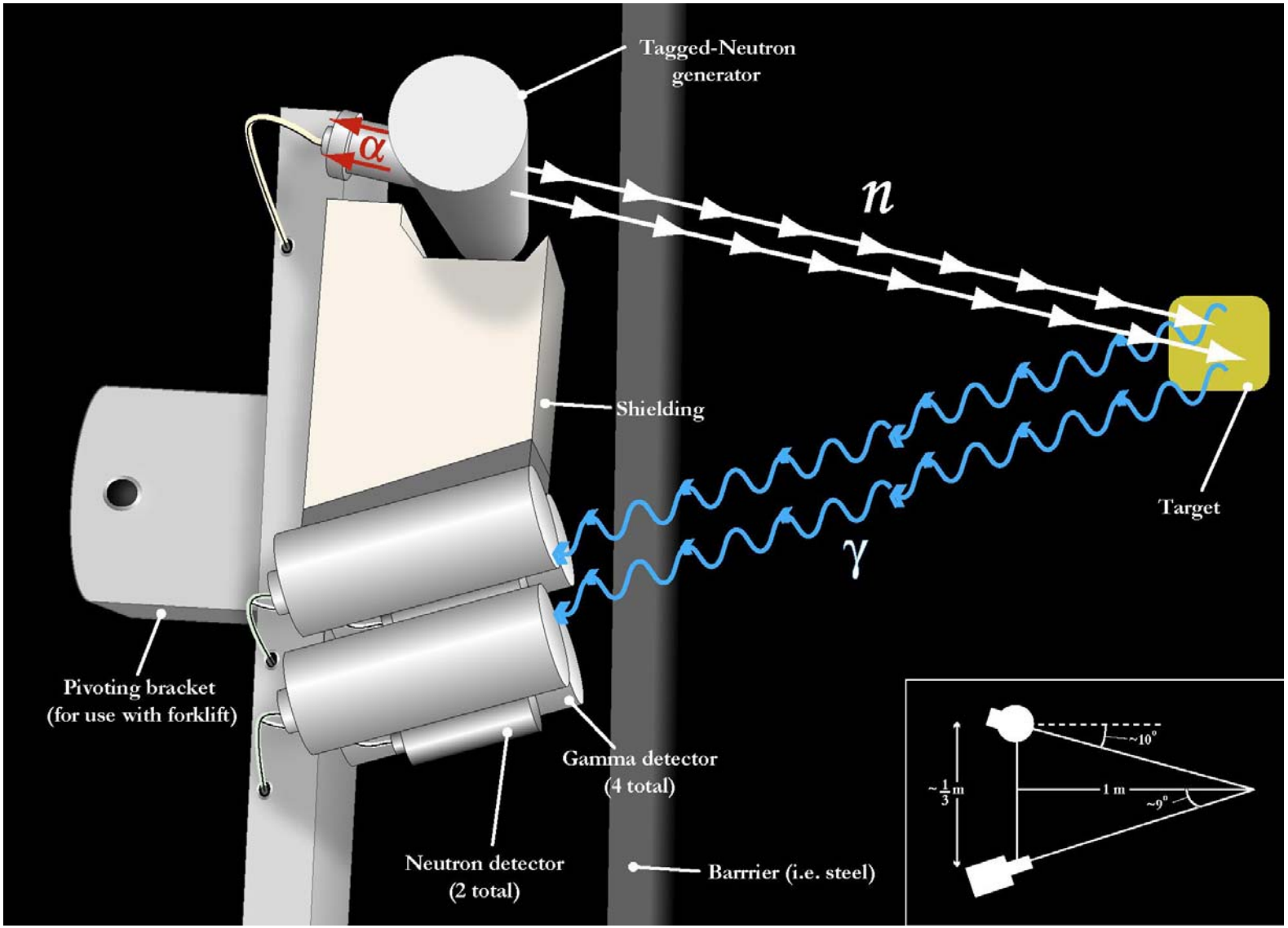
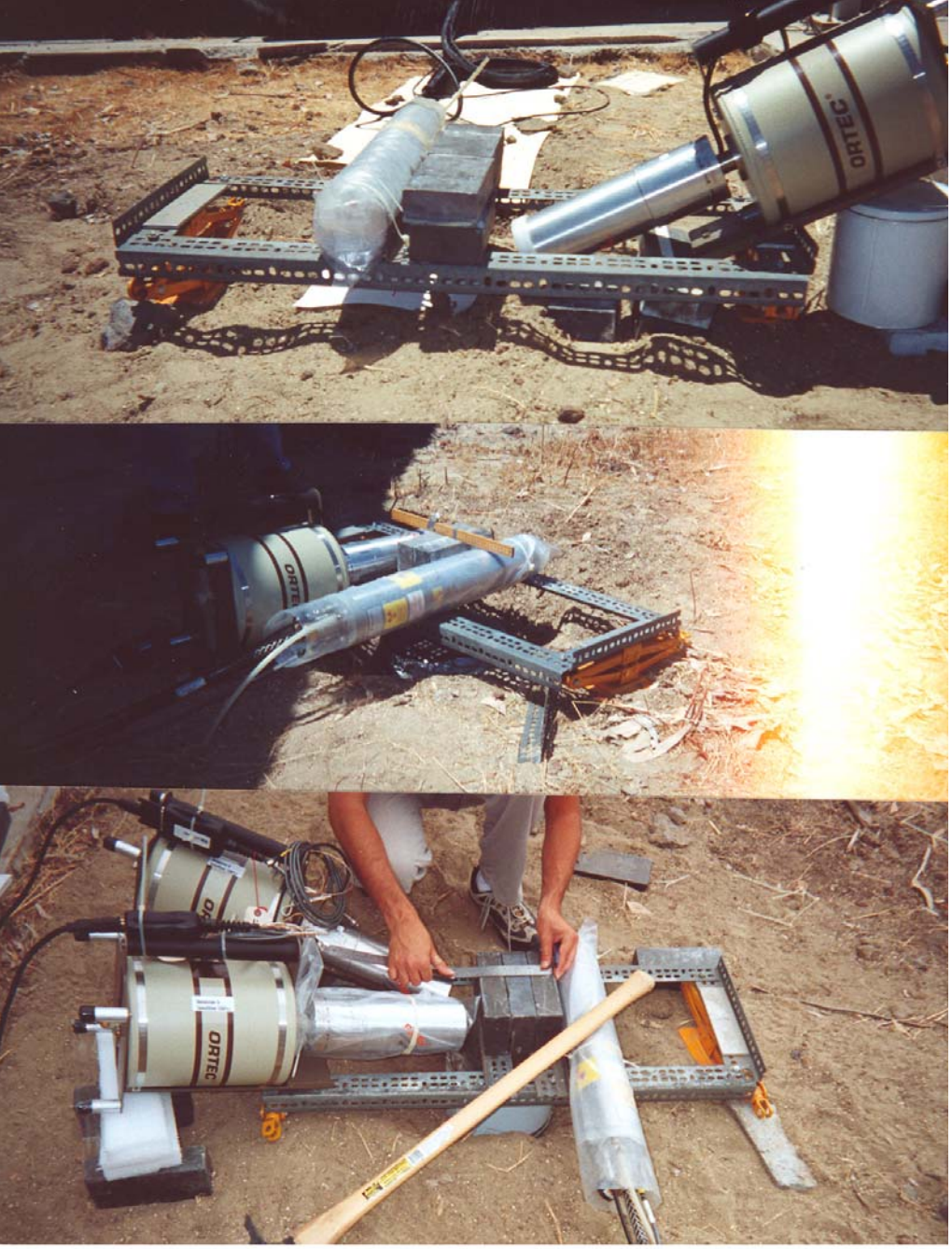


The key components of the Supersenzor system which utilizes directed fast neutrons to interrogate hidden targets



HiEnergy Technologies, Inc. MINISENZOR
Landmine Detection Tests at University of California, Irvine. December 2002

Under certain test conditions, Minisenzor (non-directional fast neutrons) is able to **identify** 5 kg of explosive simulant buried under 2” of soil.

Ongoing tests for US Army as part of HiEnergy’s contract to develop an anti-tank land-mine confirmation sensor.

Ultimate device will incorporate a Supersenzor on a mobile platform.

Fast Neutron Analysis (FNA)

- Inelastic scattering of fast neutrons
- Measurement of prompt gamma rays

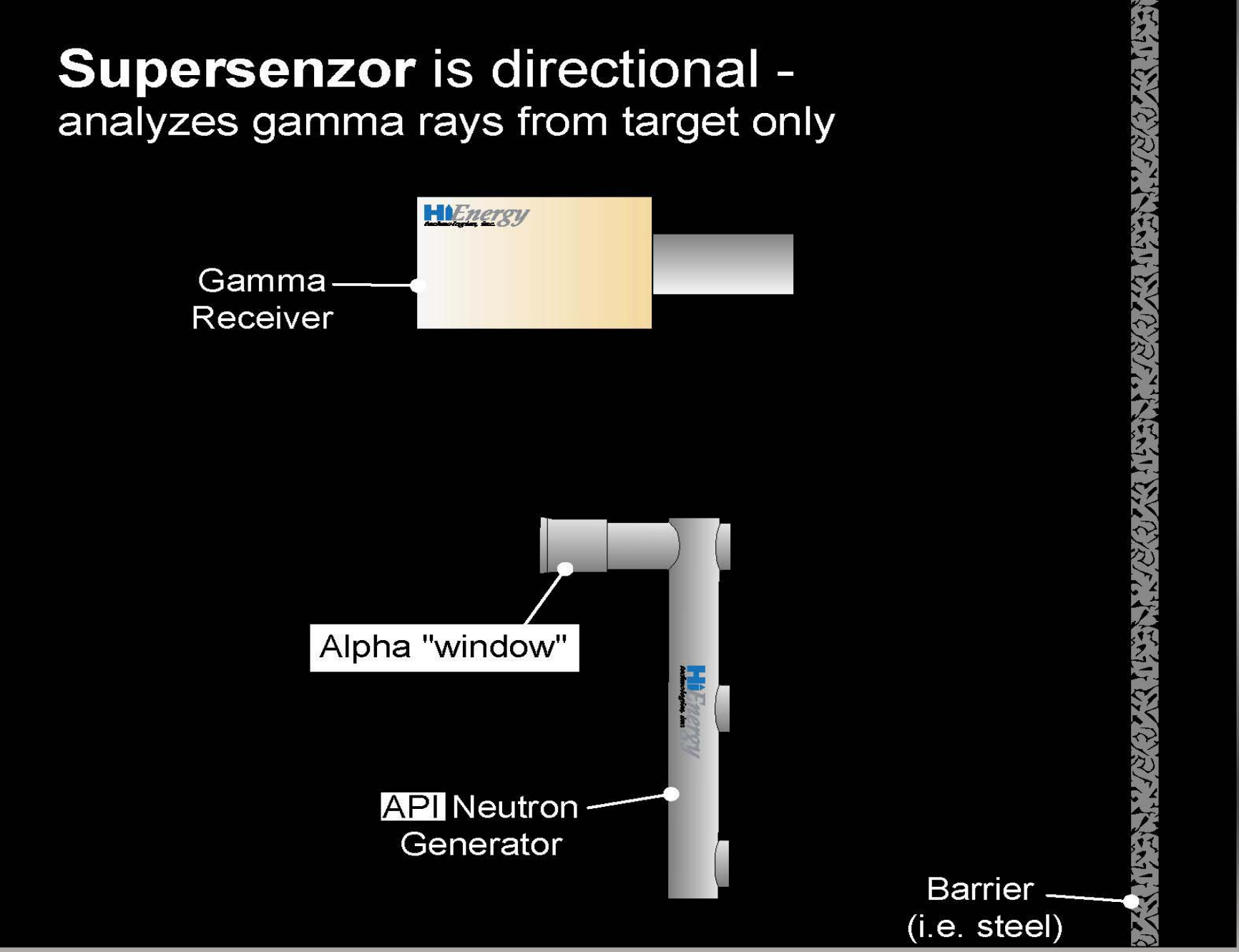
Associated Particle Imaging (API)

- Alpha-particle tagging of gamma rays
  (a virtual “beam” of neutrons)

Improved API - Supersenzor

- Real-time
- Field deployable
- A truly **STOICHIOMETRIC** system

Supersenzor is directional -
analyzes gamma rays from target only



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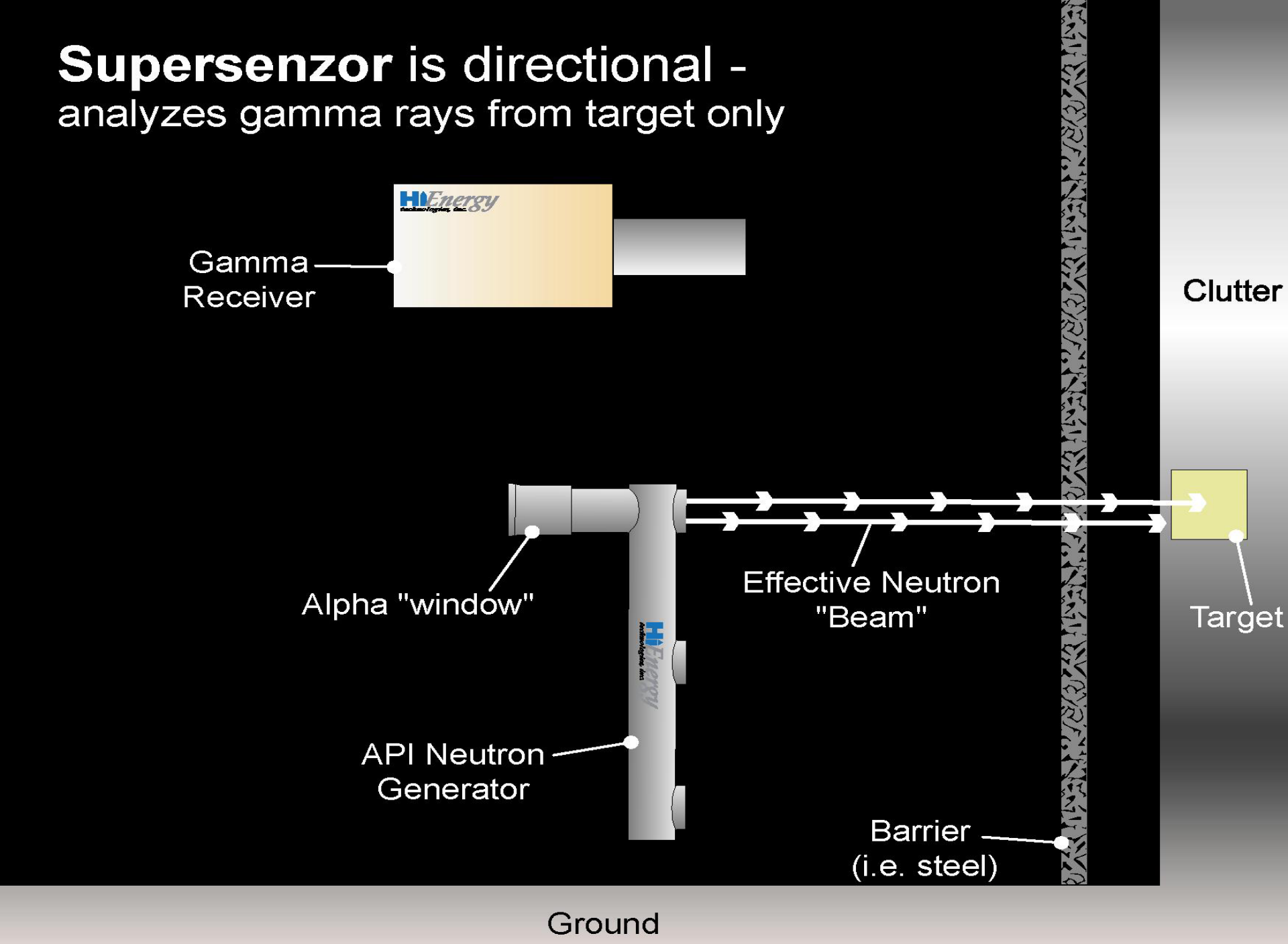

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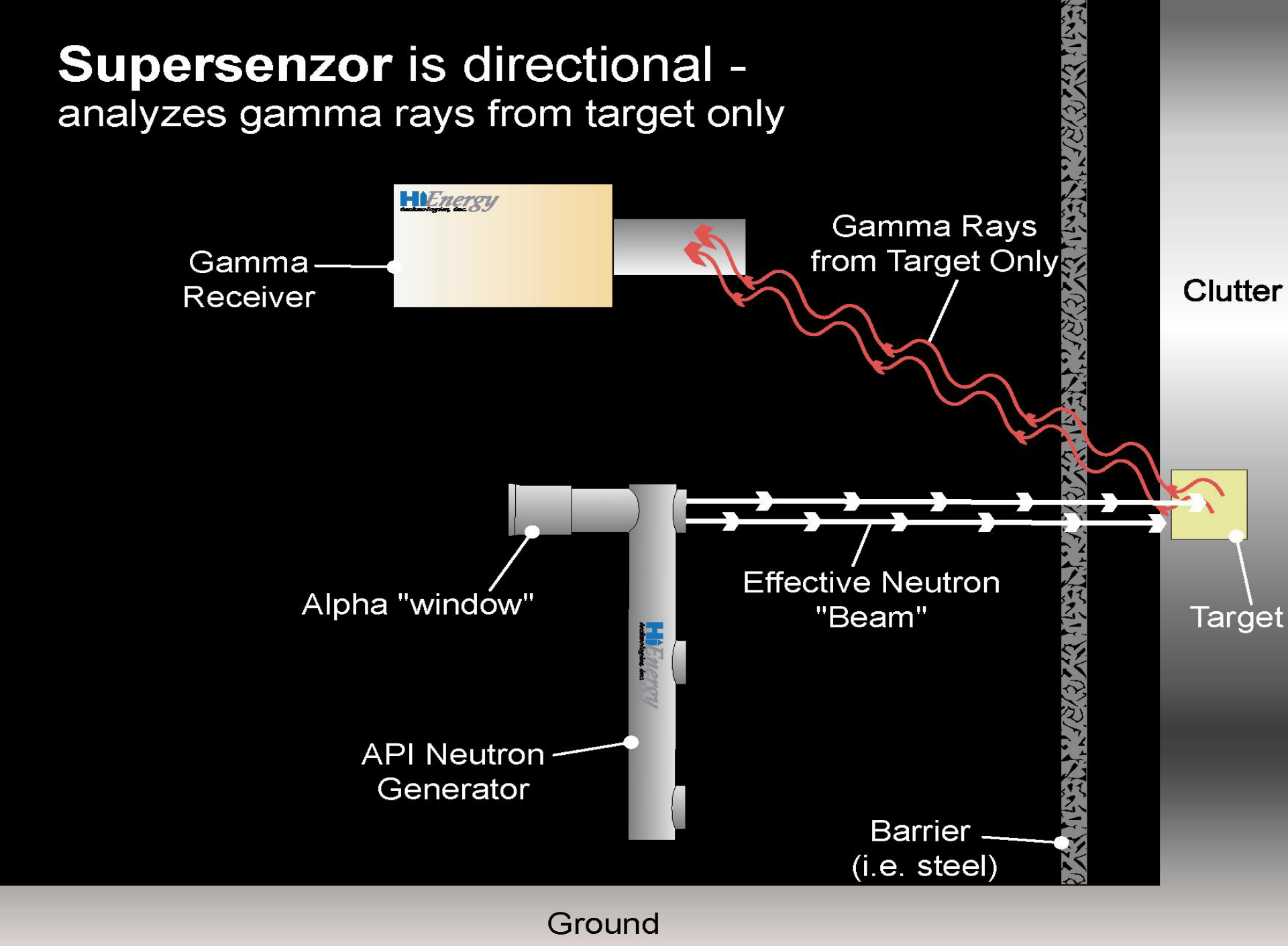
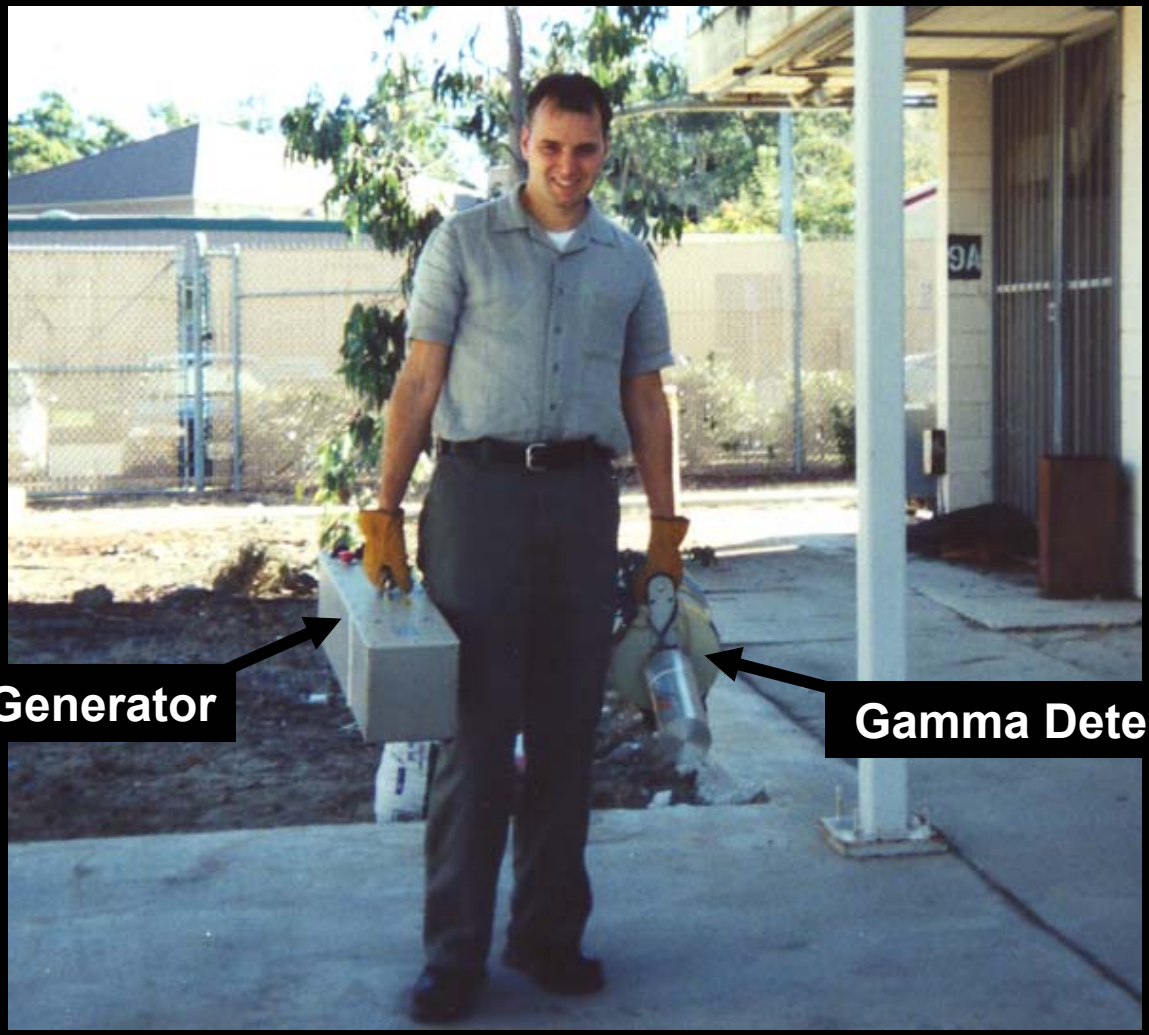


Portability



Comparison of "directional" FNA systems:

Supersenzor API vs. Ancore PFNA

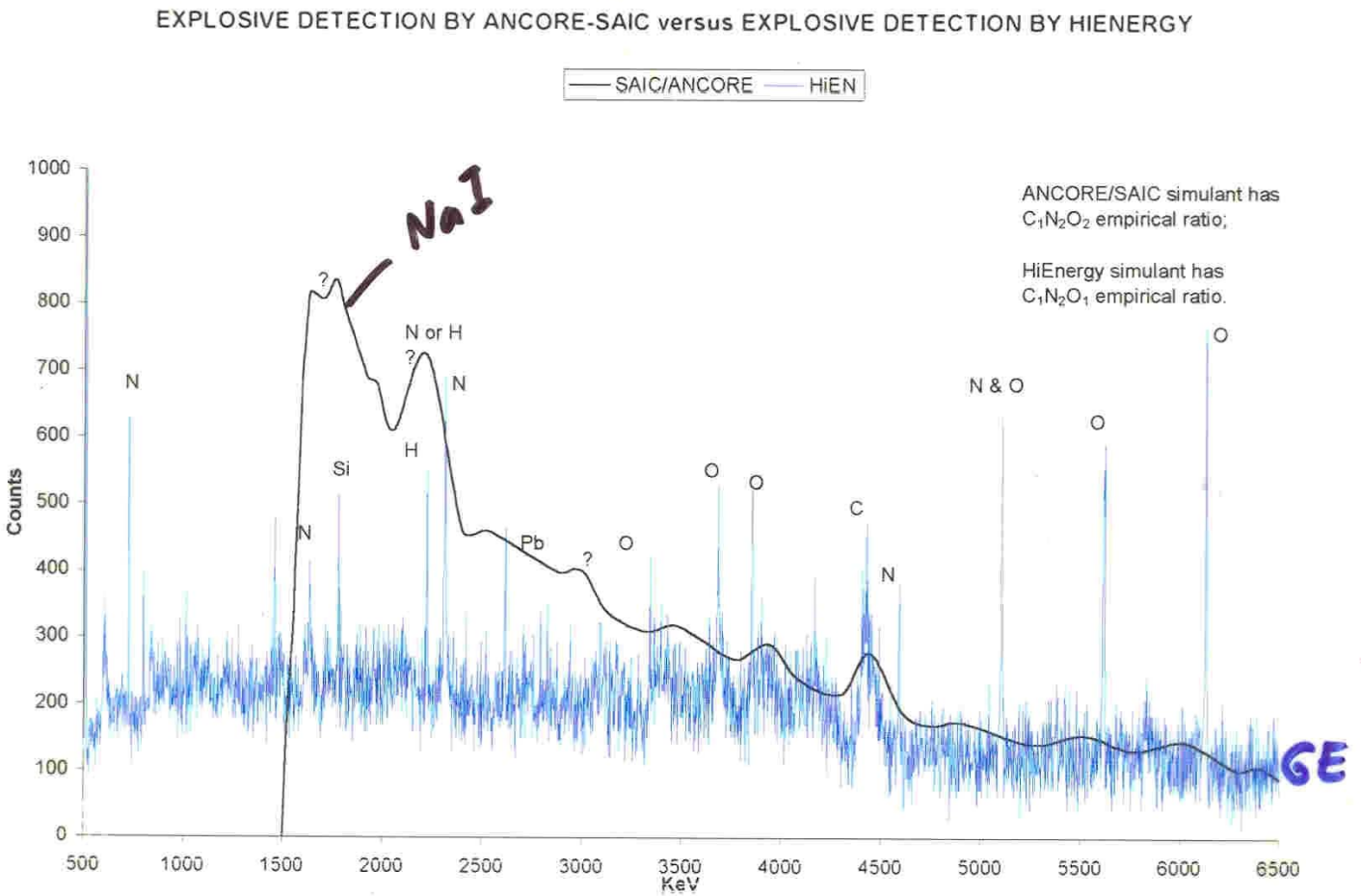
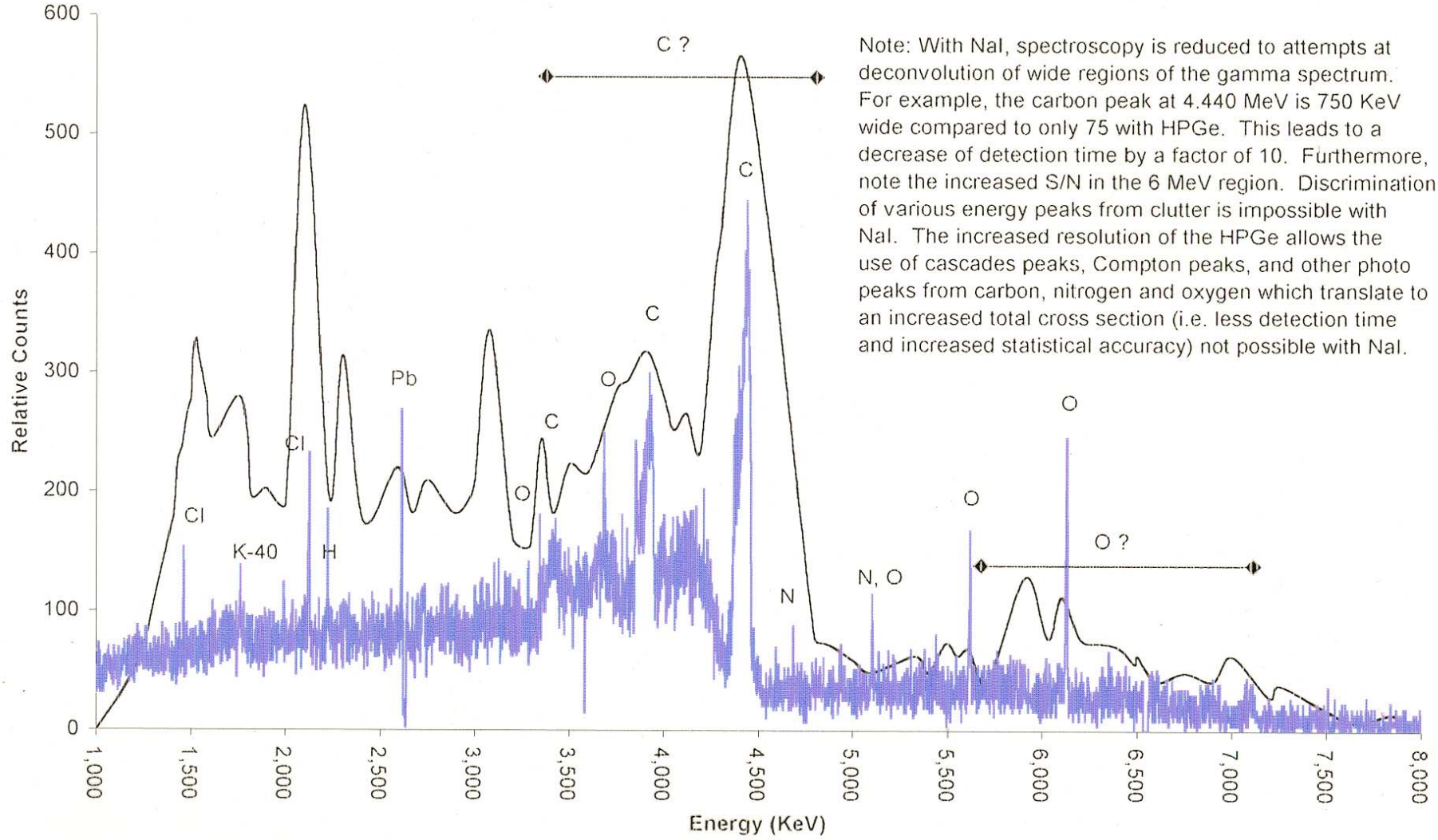


Fig. 5. Comparison of gamma spectrum quality measured by germanium detectors (resolution 0.1%; blue vertical lines) [HiEnergy] with that observed by sodium iodide (10%; line contours) [T. Gozani, et. al Nucl. Instr. Meth. B99, 753 (1995)].

Spectra of cocaine hydrochloride with NaI (black contours) by Argonne National Laboratory versus HPGe (blue peaks) by HiEnergy

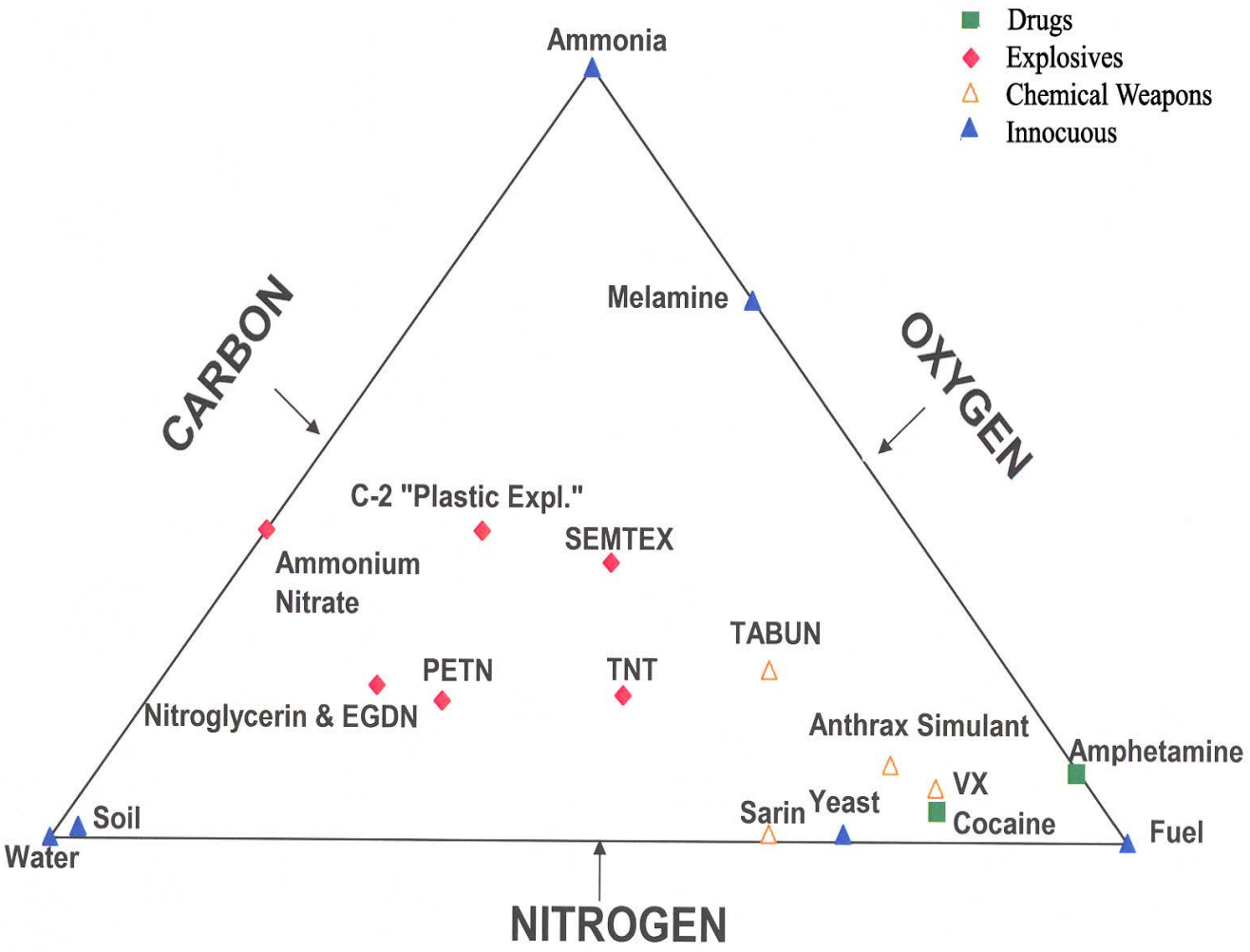


Note: With NaI, spectroscopy is reduced to attempts at deconvolution of wide regions of the gamma spectrum. For example, the carbon peak at 4.440 MeV is 750 KeV wide compared to only 75 with HPGe. This leads to a decrease of detection time by a factor of 10. Furthermore, note the increased S/N in the 6 MeV region. Discrimination of various energy peaks from clutter is impossible with NaI. The increased resolution of the HPGe allows the use of cascades peaks, Compton peaks, and other photo peaks from carbon, nitrogen and oxygen which translate to an increased total cross section (i.e. less detection time and increased statistical accuracy) not possible with NaI.

On-Line Stoichiometry

Graphical Display of 3-Element (C,N,O) Analysis

Reveals Empirical Chemical Formula

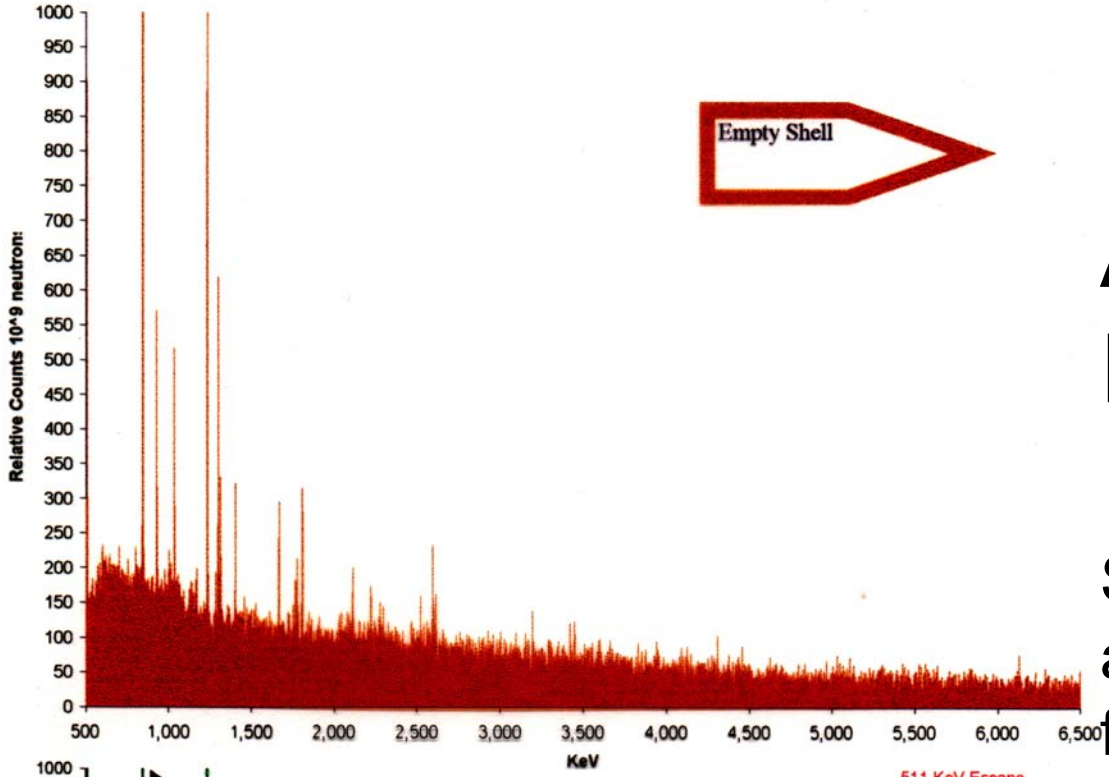


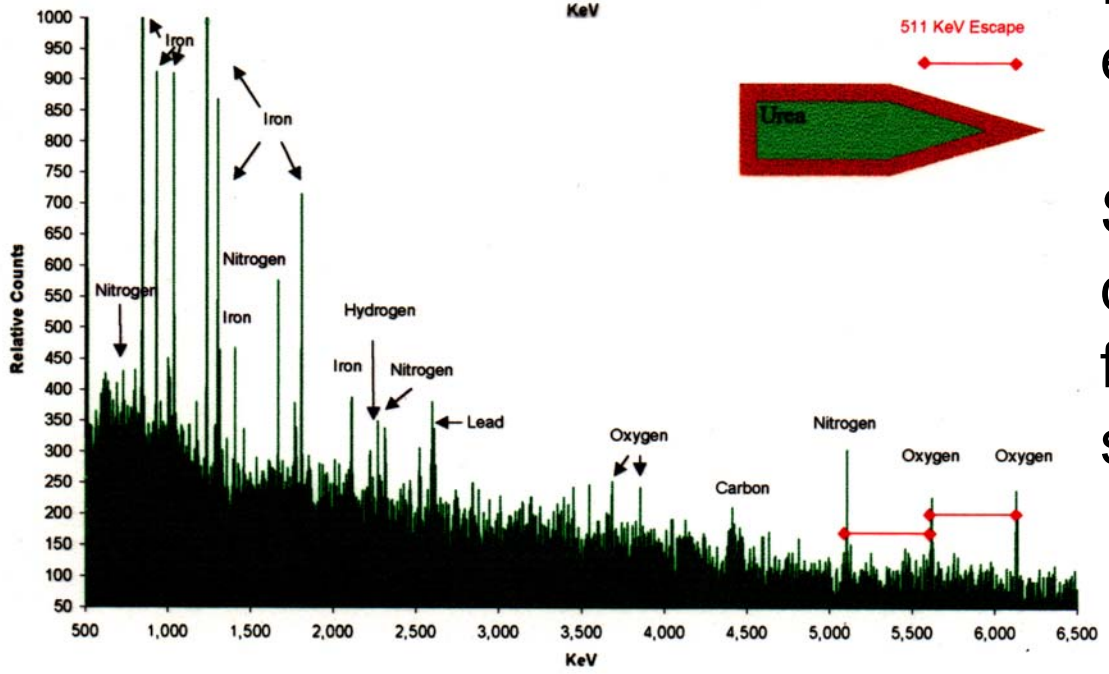
Validation of HiEnergy's systems

- Supersenzor in the laboratory
  - Cocaine hidden in rice (with US Customs)
  - Explosive filler in artillery shell
  - Distinguishing Anthrax from Yeast (DARPA)

- Minisenzor in the field
  - UXO filler* identification for US Navy
  - Land mine tests at UC Irvine

* actual explosive filler material – other tests and demonstrations were performed with suitable simulants

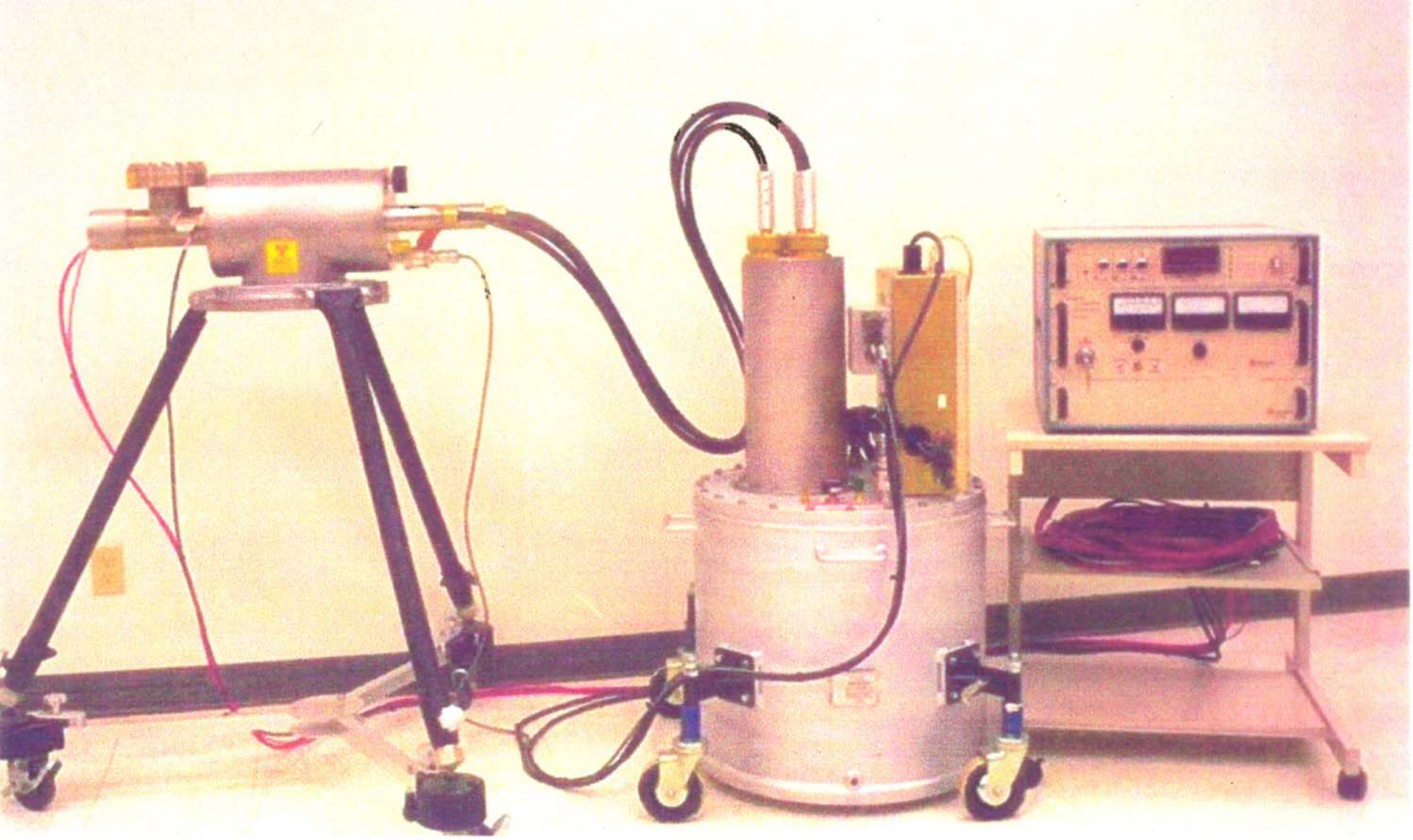




Artillery Shell Filler Test

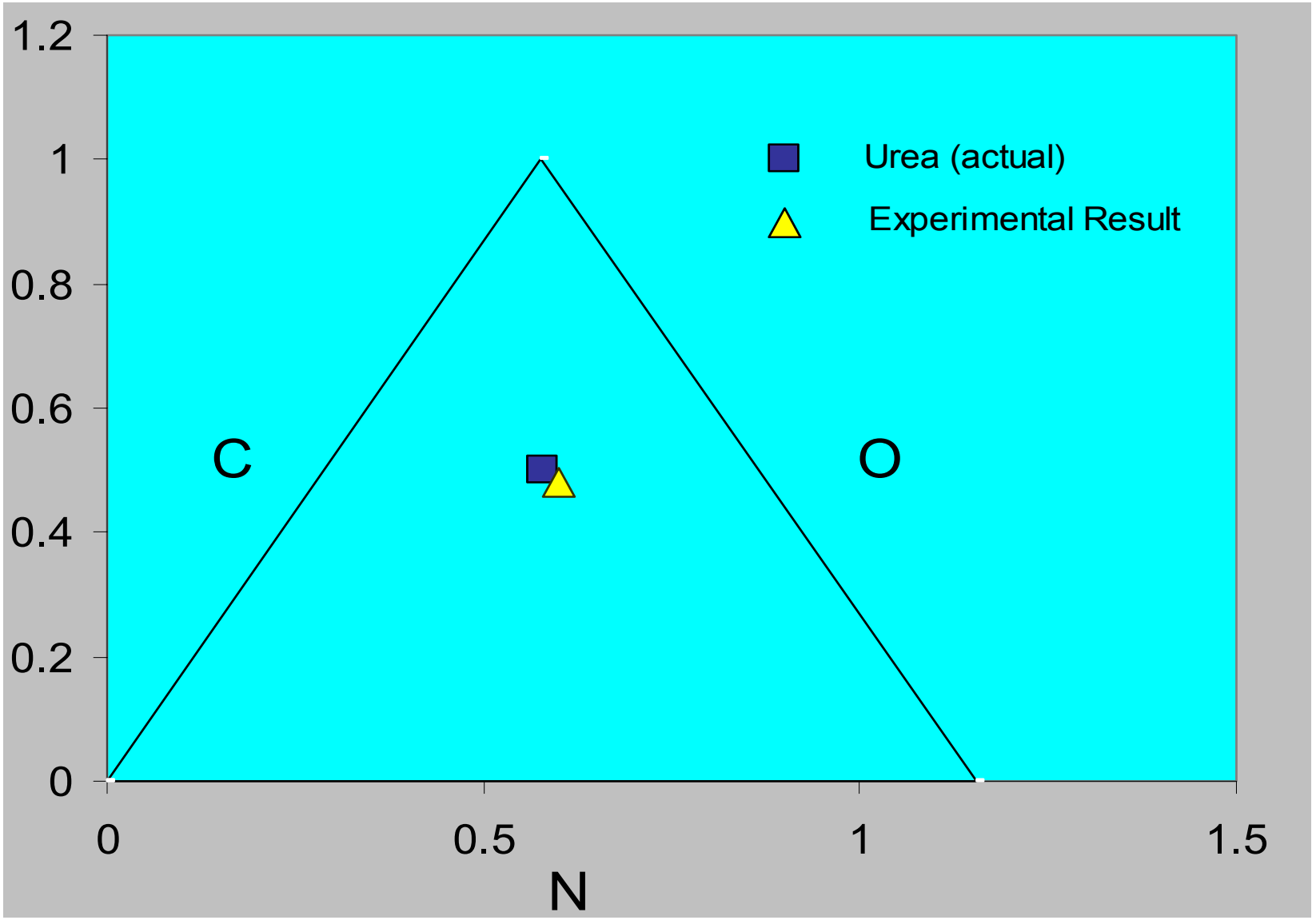
Supersenzor distinguishes an empty artillery shell from one containing an explosive simulant.

Supersenzor correctly deciphers the chemical formula of the explosive simulant.



Non-portable API Neutron Generator
with 8 kW Power Supply

Artillery shell suspended in air with polyethylene shielding And HPGe gamma ray detector



Graphical representation of results from Supersenzor interrogation of artillery shell.

Artillery Shell Filler Identification Test of Non-Portable API System

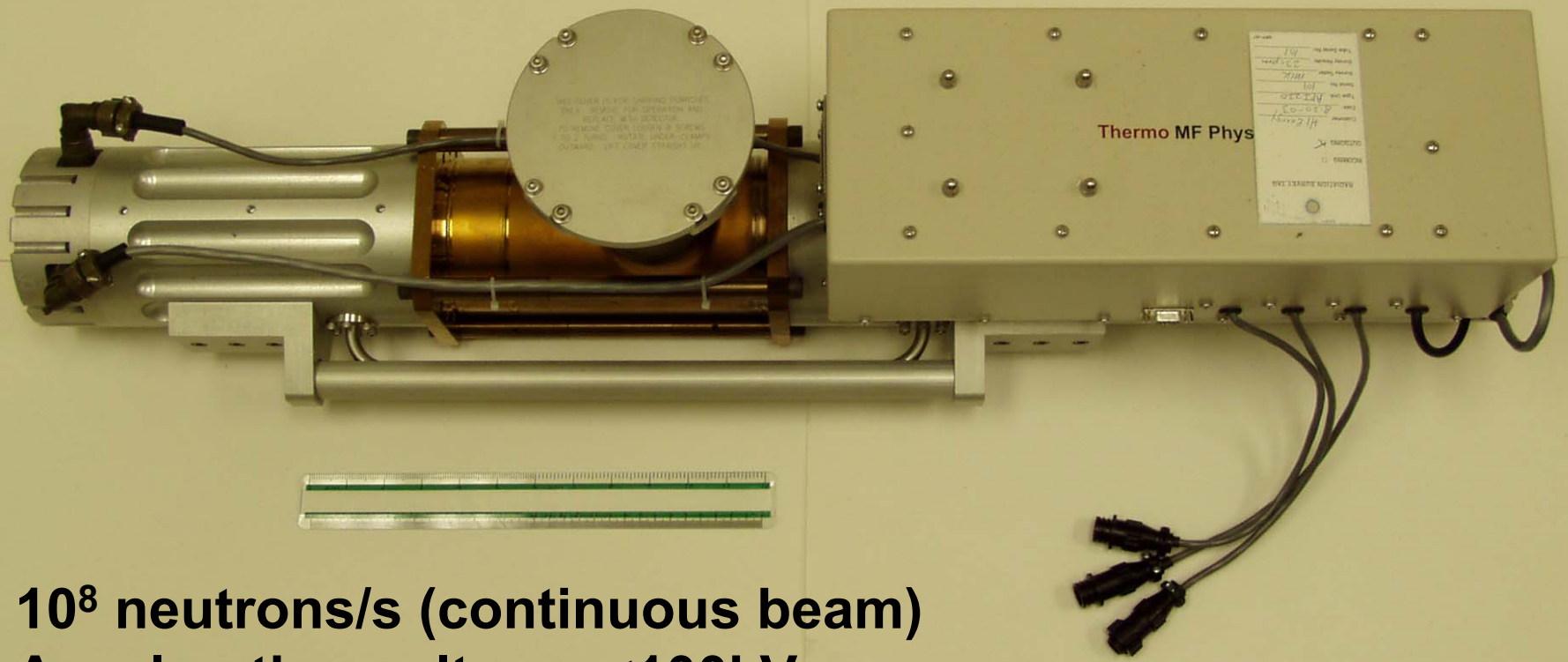
- 5 kg of explosive simulant (urea)
- Distance of 1 meter (in air)
- Actual formula:

  $C_1N_2O_1$
- Experimental results:

  $C_{1.08(\pm0.09)}N_{1.95(\pm0.17)}O_{1.00(\pm0.20)}$
- Estimated detection speeds for portable Supersenzor (5 kg in soil):

  10 ~ 300 seconds (40x faster than above)

Portable API Neutron Generator



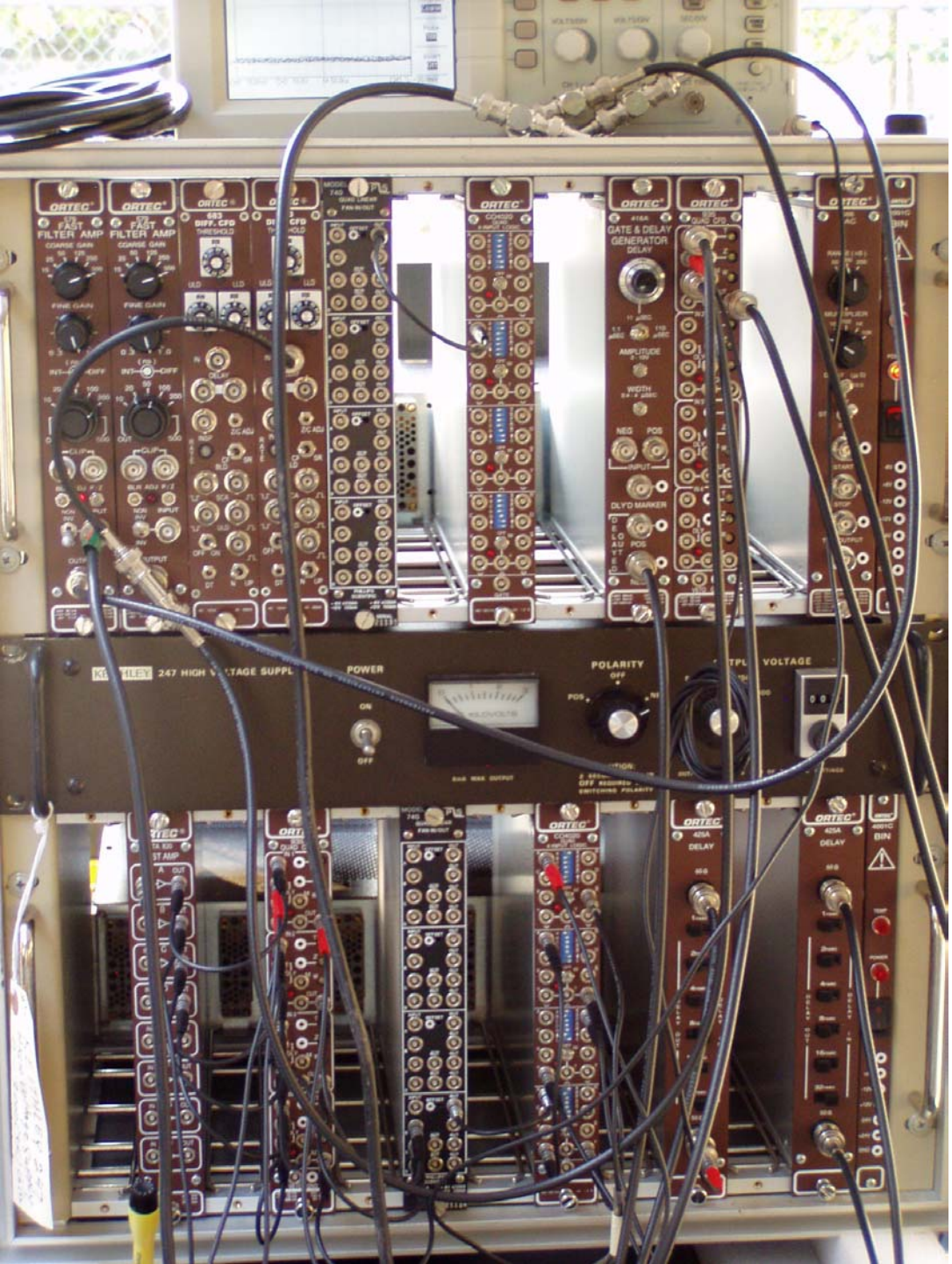
10^8 neutrons/s (continuous beam)
Accelerating voltage: <100kV
Mass (including HV power supply): 22 kg
Length: 1 m **Power: 75 Watts (24V DC)**

Electric Cooling of Detectors

First Generation:
One detector (<90% eff.)
300 Watts
Non-portable (shown)

Second Generation:
Up to 4 detectors
300 Watts
Portable (Fall 2003)

Third Generation
One detector
20 Watts



Electronics

Prototype:

Rack mounted NIM logic.
300 Watts
DSP for gamma-ray pulse height analysis.
Single-pixel (voxel).

Production:

Integrated logic and pulse analysis on a single low-power PC board with multi-voxel imaging capability.

Supersenzor
Ongoing Development

- First field tests of portable Supersenzor
- Robust data analysis algorithms
- System integration (software and/or hardware) with miniaturized electronics
- Faster detection times due to improved DSP
- Ruggedized and standardized HPGe detectors
- Elimination of liquid nitrogen cooling
- Multiple HPGe gamma ray detectors
- Multi-voxel, 3D chemical imaging capability
- Optimized radiation shielding for field use
- Remote-controlled vehicle platform