

Berkeley Nucleonics – Position Paper on Gamma vs Gamma/Neutron Pagers for Radiation Detection

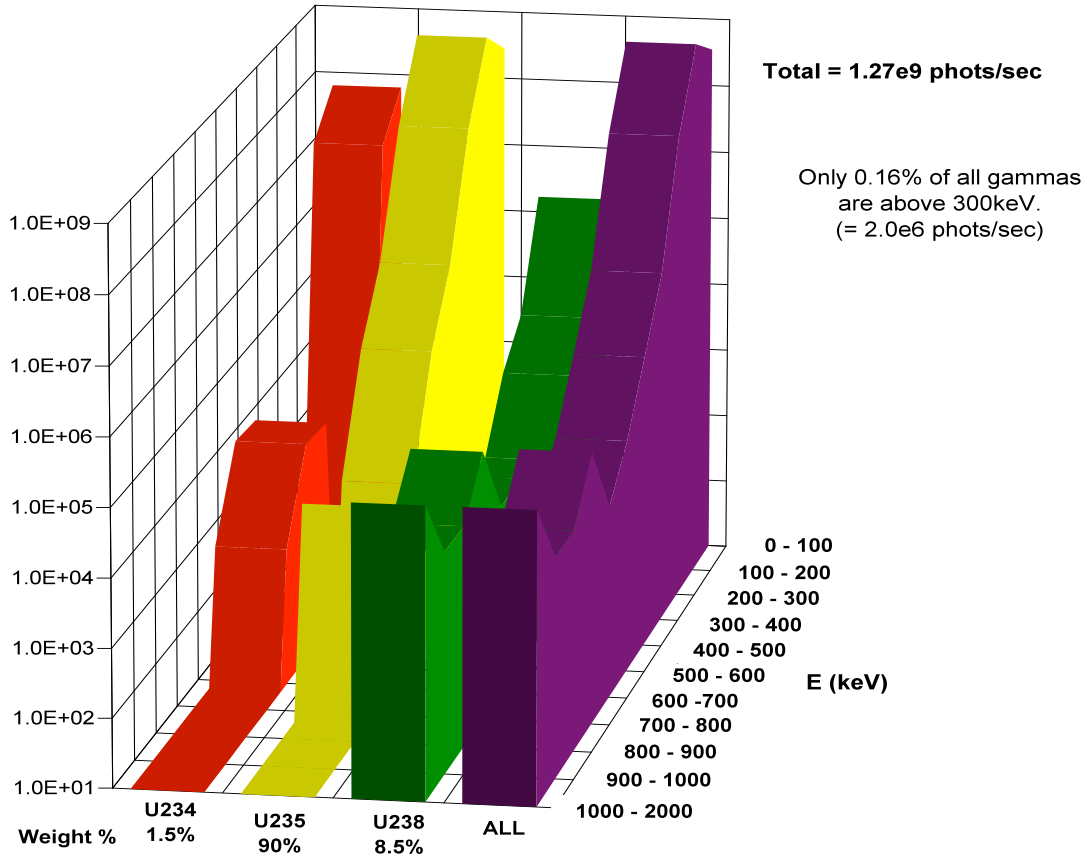
Gamma and/or Neutron Detection in Handheld Pagers

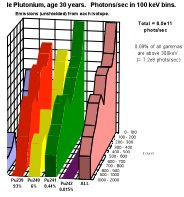
A pager-size gamma detector has superior range to detect nuclear materials than a pager-size gamma/neutron detector, even through 1” of lead shielding. Pager-size gamma/neutron detectors cost twice as much and perform the nuclear weapon detection mission less effectively than a pager-size gamma-only detector.

Point 1

Both Uranium and Plutonium nuclear weapons are relatively poor gamma emitters. However, they still emit 100 to 1000 times as many gammas as neutrons. The gamma emissions for Uranium and Plutonium nuclear weapons are presented in the 3D charts below. Most of these gammas are below 100 keV and are easily shielded. However, there are sufficient gammas above 300 keV to penetrate heavy shielding.

**15kg weapons-grade Uranium. Photons/sec in energy groups.
Emissions (unshielded) from each isotope.**





The next two charts show the effectiveness of shielding Uranium and Plutonium-emitted gammas by aluminum, iron, lead, and the nuclear material itself. Since a detectable level of gammas in a scintillation detector is only a few per second in the entire detector area, a gamma emission from a nuclear weapon of 1 photon/cm²/sec is sufficient to declare an alarm. This means that, by emitted gammas alone, a 1.27 cm × 3.8 cm scintillation detector, such as the NukeALERT 951, will easily detect 1 kg Weapons-Grade **Uranium** (WgU) through 1/2" of lead shielding at well more than 1 foot, and will easily detect 1 kg Weapons-Grade **Plutonium** (WgPu) through 1" of lead shielding at well more than 1 meter. An actual nuclear weapon, requiring 15 kg of WgU or 5 kg of WgPu, will be detectable through heavier shielding at even greater ranges. No further functional purpose is added to a pager if it can detect neutrons only at 10".

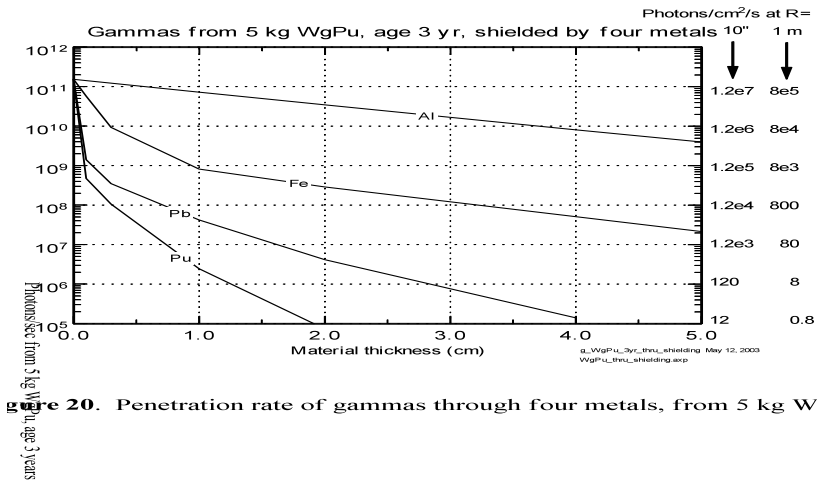
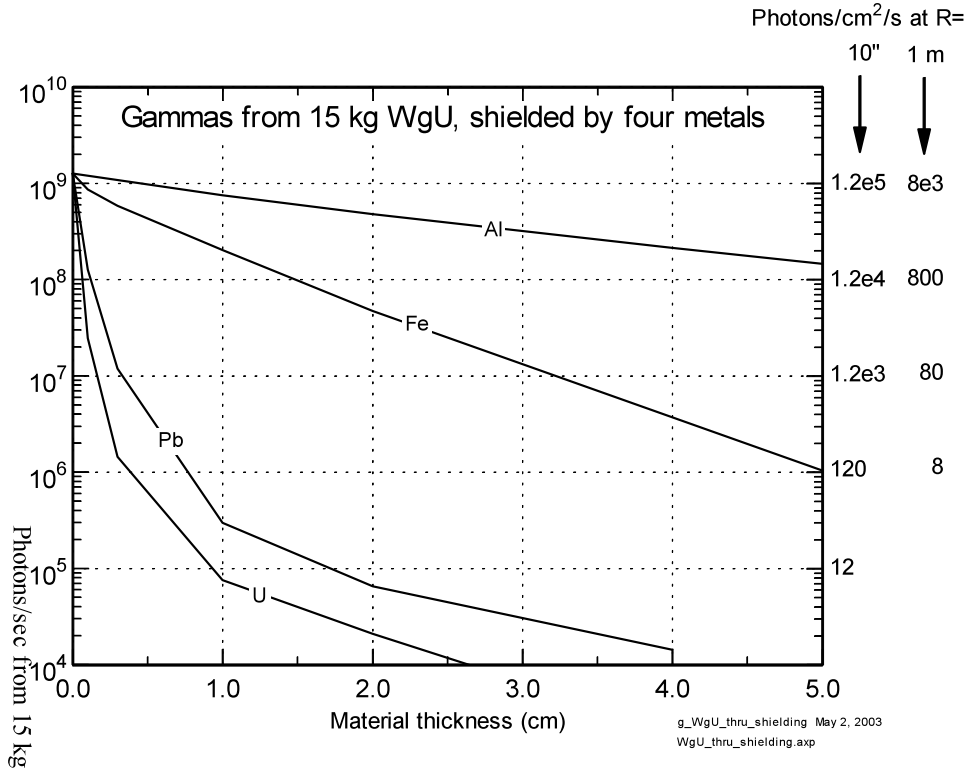


Figure 20. Penetration rate of gammas through four metals, from 5 kg WgPu, age 3 years.

Point 2

A pager-size gamma-neutron detector, by necessity, holds a smaller gamma detector to fit in the same volume as a gamma-only detector. The smaller gamma detector in the gamma-neutron pager means that the range at which it can detect nuclear weapons is reduced, with a higher probability of missing a detection. To detect nuclear weapons, or any illicit radiation, the larger the gamma detector the better.

Point 3

Only moderated neutrons can be detected with a pager-size gamma-neutron detector. Since there is no room for moderator in the case, the neutrons are moderated by the ground and by the human body. If a user detaches the pager from his or her belt and holds it up next to a package, as is correct for gamma detection, this is absolutely the wrong way to detect neutrons. By moving the neutron detector away from the moderator, the sensitivity is reduced. When a specification requires a neutron detection range of 10" from 1 kg of Plutonium, in field use that must be measured from the hip of the wearer. Without careful and repeated training, users will use a gamma-neutron detector like a gamma detector and desensitize the neutron detector, increasing the probability of missing a critical detection.

Point 4

Operationally, the detection of a gamma radiation source that does not emit neutrons does not mean that the source is not a terrorist weapon, only that the source detected cannot be used for a nuclear bomb. It still can be a contamination weapon (i.e. dirty bomb). A radiation identification unit, such as Berkeley Nucleonics Model 935 SAM Isotope Identifier, will be required to identify the isotope and determine the threat. If an Radiation Isotope Identifier must be used in every radiation detection incident anyway, then it does not make sense to have a high-cost/low performing neutron detector built in the pager along with a less sensitive gamma detector. The neutron detection mission is irrelevant ***at the first instance of detection*** and will be performed far better by the Radiation Isotope Identifier (which will identify both nuclear weapons and dirty bombs). What is important is that the first detectors have as sensitive a gamma detector as possible so that they do not miss the first detection entirely.

Point 5

The neutron distance requirement means that the detector, on the hip of the user, must be within 10" of the actual nuclear material to detect it. It is extremely unlikely that nuclear material hidden in a cargo container, truck, car trunk, or crate, will be within 10" of an inspector's hip. Being able to detect gammas from a greater distance is the critical sensitivity for first detection.

For further Information:

Berkeley Nucleonics has a technical paper breaking down the complex nuclear decay chain of Uranium and Plutonium titled *Gamma Emissions from Uranium and Plutonium* available to appropriate parties. Be warned, this is written for the informed physicist.