



Measurement Techniques for Monitored Nuclear Warhead Dismantlement: Passive Gamma Spectrometry & Neutron Multiplicity Counting

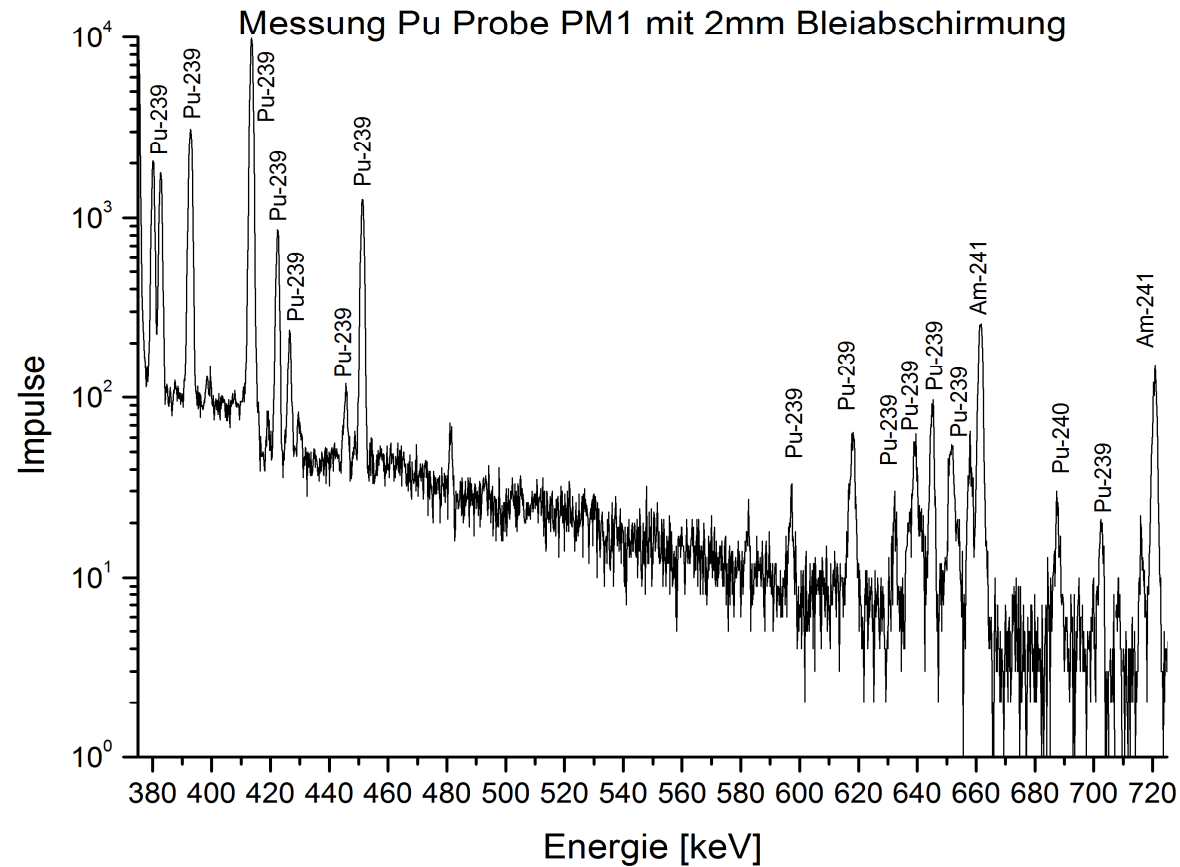
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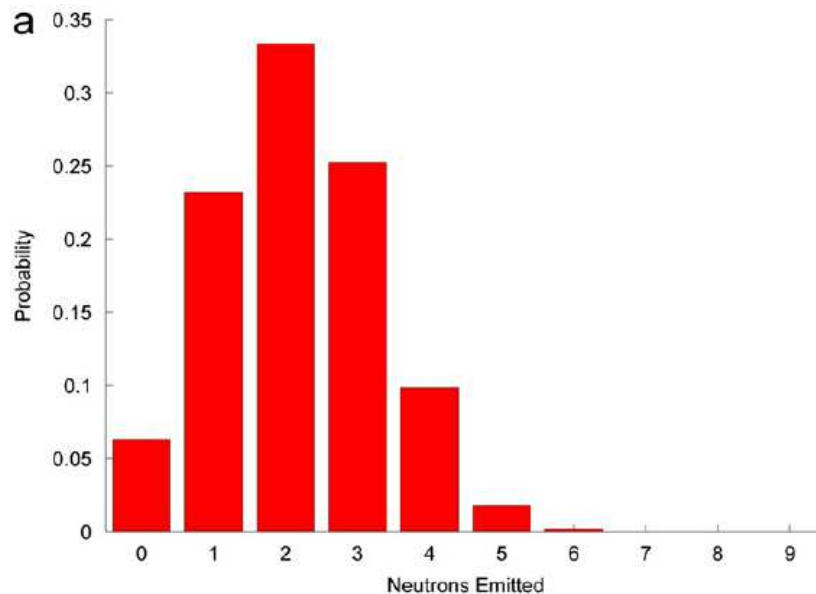
Geneva, February 2016

- Presence of plutonium
- Isotopic vector of plutonium
by passive gamma spectrometry
- Mass of Pu-240
- Presence of oxides
by passive neutron multiplicity counting

Analysis of 12.5 g PuO₂ sample (95.4 % Pu-239, 2000 s):



- PuO₂: (α ,n) reactions
- Pu: induced fission (²³⁹Pu)
- Pu: spontaneous fission (²⁴⁰Pu)



Neutron multiplicity counting (measuring Singles, Doubles and Triples coincidences) separates these three contributions

Fissile mass can be deducted from Pu-240 mass if the isotopic vector is known

Passive gamma spectrometry

- established technology
- sensitive to shielding by high-Z materials

Passive neutron multiplicity counting

- established technology in nuclear safeguards
- sensitive to shielding by low-Z materials
- for large masses corrections for spatially varying induced fission rates needed

(Göttsche & Kirchner, Nucl. Instr. Meth. Phys. Res., 2015)

- **Verification of declaration**
(combined with information barrier)
- **Chain of custody**
(in case of confirmatory measurements)
- **(nuclear material detection)**

- **HPGe gamma detectors**
 - commercially available (e.g., Canberra, ORTEC)
 - various sizes / efficiencies
 - optimized for various energy ranges
 - portable detectors available

- **Neutron multiplicity counters**
 - commercially available (e.g., Canberra)
 - high efficiency
(e.g. > 50 % for Pu-240 SF neutrons, PSMC)
 - cavity sizes adequate for warhead analyses ?

Size & weight



Pu sample

shielding of background



Source:

http://www.canberra.com/products/waste_safeguard_systems/neutron-safeguards-systems.asp

- Complexity of hardware & software
medium to high
but well established
- Measurement times required
ca. 10 – 60 min

- Design developed within the Trilateral Initiative
 - AVNG: Attribute Verification System with Information Barrier for Plutonium with Classified Characteristics utilizing Neutron Multiplicity Counting and High-resolution Gamma-ray Spectrometry
- AVNG prototype built in Russia (with support of LANL and LLNL)
- AVNG demonstration in Russia in 2009 for a joint US/Russian audience
- Design of a “next generation” Attribute Measurement System (NG-AMS) by LANL
- Joint U.S.-U.K. Technical Cooperation for Arms Control:
Testing of gamma spectrometry and neutron multiplicity counting