How to detect illicit uranium

How can you detect the presence of enriched uranium amid the six million cargo containers that arrive at U.S. seaports annually? Jennifer Church of the Lawrence Livermore National Laboratory explained how in her talk on "Detection of Nuclear Material in Cargo Containers via Neutron Interrogation" on 24 July at the American Association of Physics Teachers meeting in Syracuse. Left alone, enriched uranium, like natural uranium, would emit a slow steady stream of gamma rays resulting from the daughters of the long-lived alpha decay of uranium-235 and 238. The daughters of the uranium isotopes, thorium-231 and 234, have half lives of 24.6 hours and 24.5 days, respectively, much shorter than the billions of years that uranium isotopes take to decay, but this is still longer than the time for speedy detection of contraband cargo.

But enriched uranium will respond to a probe that can uniquely detect it – neutrons, the same particles that would cause the enriched uranium to fission in a nuclear reactor or a nuclear bomb. As Church reported in her talk, the goal is to reliably scan large, inhomogenous containers in less than 60 seconds. Isolated fissions of enriched uranium induced by neutrons will produce fission products which beta decay with short half lives (less than 160 seconds), and the gamma rays emitted by the daughters of the beta decays (they are called "beta delayed gammas") are the "signature" that is looked for in detecting enriched uranium. Church reported the results of irradiating uranium by 7 or 14 MeV neutrons for 30 seconds, then scanning for "beta delayed gammas" after 100 seconds. Data for 7 MeV neutrons show ability to distinguish between uranium shielded by three feet of wood from background radiation.

Presumably this technique would be able to detect other fissionable isotopes, such as plutonium-239, but Church didn't spectifically report about that (perhaps because plutonium is too hazardous a material to experiment in this way with).