AGA 3: Fissile Materials and Detection

Time: Thursday 14:00–16:30 Location: AGA-H19

Invited Talk AGA 3.1 Thu 14:00 AGA-H19

What does archaeology have to do with nuclear disarmament, and why is this something for physicists? — •Malte Göttsche — RWTH Aachen University, Aachen, Germany

Archaeologists use the remains of the past to solve puzzles of history. This involves surveying, excavation and eventually the analysis of the collected data. In a sense, all of this will be required to gain confidence in a nuclear weapon state's disarmament process: A nuclear archaeology toolbox is needed to reconstruct past nuclear programs. In particular knowledge of past fissile material production is crucial to assess today's inventories. Such reconstruction could include the collection of information from open sources or provided documentation ("surveying"). Measurements of samples from shut-down nuclear facilities and of the waste they produced can provide a signature of their past operations ("excavation"). Lastly, all information will need to be analyzed, for instance to assess whether it paints a consistent picture. This talk will highlight several technical opportunities in this context, including: what and how one can learn from measuring certain isotopic ratios in structural elements of reactor cores, or the isotopic composition of waste from reprocessing where the weapons-usable plutonium is separated from fuel after its irradiation in a reactor. A statistical approach based on Bayesian inference is presented as integrated analysis tool which can jointly take into account both information from acquired data/documentation and the measurements. Lastly, we will look at how nuclear archaeology could be applied in practice, for example to assess the North Korean nuclear program.

Invited Talk AGA 3.2 Thu 14:45 AGA-H19

Parametric Estimate of Nuclear Material Usage in North Korea's Last Nuclear Test — •Robert Kelley and Vitaly Fedchenko — SIPRI Stockholm

North Korea (DPRK) has carried out six underground nuclear explosions. The first five had yields well below 20 kilotons and could be safely estimated to be single-stage fission devices. The last test had a yield estimated at closer to 250 kt. This was almost certainly a thermonuclear test using two stages and considerably more fissionable material than a single stage device. Yield estimates for single stage devices have few uncertainties and are acknowledged roughly by nuclear powers. But the amount of fissionable material in a thermonuclear stage is much harder to estimate. The authors used known characteristics of the DPRK test and some historical US devices to make such an estimate. There are a number of uncertainties that they explored. The conclusions can be used for stockpile estimates for DPRK weapons.

AGA 3.3 Thu 15:30 AGA-H19

Muons for Peace: Revisiting Cosmic Rays for Fissile Material Detection — •Moritz Kütt and Alexandra Datz — Institute for Peace Research and Security Policy at the University of Hamburg

Over the last decades, researchers proposed several practical applications for muons created from cosmic rays. In the field of nuclear security, non-proliferation and disarmament, several groups simulated and tested muon tracker setups, mostly for inspection of cargo. This contribution revisits existing work, and outlines future research pathways. Going beyond the common approach of muon tomography, fissile material detection could benefit from muon telescopes and the detection of muon-induced reactions. The first method has applications for the demonstration of the absence of fissile material in large, inaccessible structures (e.g. concrete bunkers), the second could be used to provide new ways to authenticate fissile material.

AGA 3.4 Thu 16:00 AGA-H19

Simulations to Discriminate Nuclear Weapon Neutron Emissions from Cosmic Ray Background — •Lennart Wilde[1] and Moritz Kütt[2] — [1]Nuclear Verification and Disarmament, RWTH Aachen University — [2]Institute for Peace Research and Security Policy at the University of Hamburg

Finding nuclear weapons is difficult, in particular if stored in hardened concrete structures, e.g. aircraft shelters. Potentially, the neutrons inevitably emitted by the fissile material within weapons could be used to detect their presence or absence. High absorption in thick concrete walls, together with the cosmic ray neutron background complicate potential measurements. This work uses Monte Carlo particle transport simulations to determine how directional information of neutron emissions could improve future detection capabilities. Using a common German aircraft shelter as a case study, we show that neutrons of a weapon inside are leave the structure mostly through the steel door. At the same time, the bunker structure partially shields a neutron detector from cosmic neutron background radiation. Based on our results, we can make recommendations for detector shielding and placement to improve sensitivity and reduce measurement time.