AGA 2: Nuclear Archeology

Time: Wednesday 16:00–17:00 Location: HS HISKP

AGA 2.1 Wed 16:00 HS HISKP

Applying neural networks in nuclear archaeology with nuclear reprocessing waste — •Fabian Unruh[1] and Malte Göttsche[1,2] — [1]PRIF – Leibniz-Institut für Friedens- und Konfliktforschung — [2]Technische Universität Darmstadt

Nuclear reprocessing waste is obtained by the separation of plutonium—potentially used for nuclear weapons—from nuclear reactor fuel. An analysis of the isotopic waste composition reveals information about the irradiation process and is useful for verifying fissile material declarations in arms control agreements.

For the analysis of waste, we simulate the nuclear reactor at Yongbyon, DPRK, and apply neural networks for the reconstruction of burnup and cooling time of several irradiation campaigns ("batches"). First, fully-connected neural networks are trained on isotopic ratios of reprocessing waste from a single batch for the reconstruction. To reduce laboratory costs in an application, the most important isotopic ratios for the reconstruction are selected by applying a gradient-based metric. Finally, posterior distributions are obtained by conditionally invertible neural networks using the reduced isotopic ratio set and the prospect of resolving different batches in the waste is explored.

The methodology successfully reduces the set of isotopic ratios without deteriorating the reconstruction capabilities. The applied neural networks yield multi-modal posterior distributions for the irradiation parameters of different batches. The techniques contribute to making nuclear archaeology for reprocessing waste suitable for application by addressing challenges of costly measurements and mixtures of waste.

AGA 2.2 Wed 16:30 HS HISKP

Using nuclear reactor waste to understand past HEU production — •Max Schalz[1] and Malte Göttsche[2,3] — [1]RWTH Aachen University, Aachen, Germany — [2]PRIF Leibniz-Institut für Friedens- und Konfliktforschung, Frankfurt am Main, Germany — [3]Technische Universität Darmstadt, Darmstadt, Germany

Nuclear archaeology offers methods to reconstruct the past fissile material production, measuring nuclide ratios in nuclear waste and comparing these with simulated datasets. So far, nuclear archaeology applied to the plutonium path proved more successful than nuclear archaeology applied to the highly enriched uranium (HEU) path. Challenges in the enrichment nuclear archaeology are, amongst other things, varying natural abundances of trace nuclides such as U234.

In this presentation, we propose a holistic approach where nuclear archaeology is applied to the nuclear fuel cycle (NFC) as a whole i.e., to the plutonium and HEU paths simultaenously. Such a combined method could allow to extract information on U234 from the plutonium path and use it in turn to improve reconstruction of the HEU path. We model a subset of the Russian military NFC to investigate the impact of key enrichment parameters on HEU production and to determine if the combined approach could improve understanding of past HEU production in this scenario.