# AGA 5: Safeguards

Time: Thursday 14:00–15:00 Location: KH 00.016

AGA 5.1 Thu 14:00 KH 00.016

**Assessing safeguards challenges in compact reactors through antineutrino detection** — •Sarah Friedrich, Robin Mentel, Yan-Jie Schnellbach, and Adhitya Sekhar — Technische Universität Darmstadt, Germany

Small Modular Reactors (SMRs) and advanced reactor and fuel types promise enhanced nuclear safety and greater operational flexibility, but they may also introduce new challenges to safeguarding efforts. To support the monitoring of SMRs and the detection of nuclear material diversion, we propose employing antineutrinos, which can be detected by a liquid-organic time-projection chamber outside of the reactor building, allowing non-intrusive, continuous, real-time measurements. The objective is to identify undeclared shutdowns, verify declared operational parameters and detect the diversion of nuclear material.

Our research builds on computational reactor simulations performed with OpenMC and Geant4 for a prototype 300-MWth pressurized water SMR, which allows us to investigate a cluster of several SMRs in close proximity to one another. We analyze how the energy spectrum of detected antineutrinos changes over time with a special focus on the spectrum before and after the declared shutdown of one module, where refuelling takes place. In a further step, we investigate whether the number and spectrum of detected antineutrinos can be used to identify undeclared shutdowns of a module.

AGA 5.2 Thu 14:30 KH 00.016

**Developing antineutrino-based safeguards for naval reactors** — •Robin Tobias Mentel, Sarah Friedrich, Yan-Jie Schnellbach, and Adhitya Sekhar — Technische Universität Darmstadt

In a world with an increasingly chaotic security landscape, the danger of nuclear proliferation is rising. In recent years, a potential proliferation concern has emerged with the planned employment of nuclear propulsion in submarines by Non-Nuclear Weapon States under the NPT. A prominent example of this is the sale of conventionally armed, nuclear-powered attack submarines by the US and the UK to Australia under the AUKUS agreement. Here, it is important to give safeguards inspectors powerful tools for a comprehensive and reliable safeguards regime, capable of detecting a diversion of weapons-grade nuclear material. We present our research on the development and the detailed simulation of antineutrino monitoring of a few nuclear-powered submarines anchored in the base of a consenting host state. To this aim, we will simulate the antineutrino emission from a naval reactor, simulated by OpenMC, and the subsequent detection in a tonne-scale active medium a few meters away, using Geant4. While focusing on the type of nuclear reactors relevant for the AUKUS-class submarines, we will explore the plausible parameter space of nuclear reactors typically employed in other submarines in terms of enrichment fraction (20 to 97%), reactor power (50 to 150 $MW_{th}$), burnup, and reactor geometry, like hexagonal and rectangular symmetry. Finally, we explore ways to implement this technique in the context of safeguards, including detector positioning, sensitivity, and integration times.