III. Physikalisches Institut B | Aachen Institute for Advanced Study in Computational Engineering Science | RWTH AACHEN UNIVERSITY

Bachelor and Master thesis topics 2019 (physics)

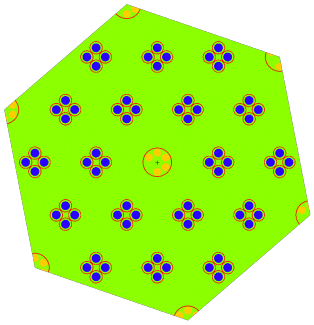
Nuclear Verification and Disarmament Group

Independent estimates assume that fissile material stocks amount to 500 tons of plutonium and 1,400 tons of highly-enriched uranium, much of which is available to build nuclear warheads. Whether it be North Korea, the United States or any other nuclear weapon state, even countries' own assessments of their produced fissile materials bear significant uncertainties. This project seeks to develop new methods to reduce these uncertainties.

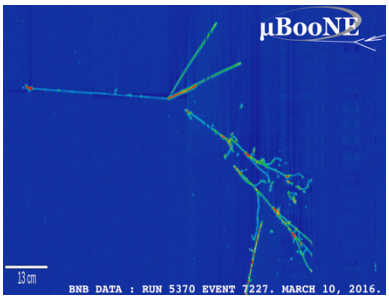
To deduce how much plutonium was produced in a reactor, samples from structural elements in the reactor core can be taken. Measurements of trace isotopes that capture neutrons can be used to deduce the integral of neutron flux over irradiation time.

Another project to determine past plutonium production is examining liquid argon detector designs to measure the antineutrino flux from radioactive waste (which stem from beta decay of fission products). From this, the amount of radioactive waste could be determined.

Inside a reactor building



Simulation model of a reactor



Neutrino event in the liquid argon detector μBooNE

B.Sc.:

- You will use computer codes to simulate reactor operations to determine the influence of various operational parameters such as the reactor power on the concentrations of trace isotopes.
- You also have the opportunity to work with `GEANT4`, the standard detector simulation tool in high energy physics, while contributing to a feasibility study regarding the use of imaging liquid argon detectors for measuring the antineutrino flux from nuclear waste.

No prior knowledge on neutron physics, reactor and detector simulations or programming is necessarily required, but will be acquired.

M.Sc.:

- We plan to extend the method by measuring several isotopic ratios to examine to which extent further parameters in addition to the neutron fluence can be deduced. Studying reaction cross-sections and simulating the irradiation behaviour of isotopes, you will choose the best suited isotopic ratios and develop the analysis algorithm.
- You will also have the chance to hone your data analysis skills by investigating, with the aid of computer simulations, the performance of state-of-the-art liquid argon detector designs for radioactive waste safeguarding.

While no specific prior knowledge is required, you will learn about neutron physics, programming, computer simulations and data analysis techniques.

Contacts Prof. Dr. Malte Göttsche, goettsche@aices.rwth-aachen.de
Dr. Madalina Chera, chera@aices.rwth-aachen.de