Working Group on Physics and Disarmament
Arbeitsgruppe Physik und Abrüstung (AGA)

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Zur Abrüstung, der Verhinderung der Verbreitung von Massenvernichtungsmitteln und der Beurteilung neuer Waffentechnologien sind naturwissenschaftliche Untersuchungen unverzichtbar. Auch bei der Verifikation von Rüstungskontrollabkommen werden neue Techniken und Verfahren benötigt und eingesetzt. Schwerpunkte in diesem Jahr bilden Themen wie die nukleare Abrüstung, Verifikation bzw. die Detektion von Nuklearanlagen und Materialien, Raketenabwehr und Zerstörung von Nuklearsprengköpfen, neue militärrelevante Technologien wie Drohnen. Die Fachsitzung wird von der DPG gemeinsam mit dem Forschungsverbund Naturwissenschaft, Abrüstung und internationale Sicherheit FONAS durchgeführt. Die 1998 gegründete Arbeitsgruppe Physik und Abrüstung ist für die Organisation verantwortlich. Die Sitzung soll international vorrangige Themen behandeln, Hintergrundwissen vermitteln und Ergebnisse neuerer Forschung darstellen.

Overview of Invited Talks and Sessions

(Lecture hall HS HISKP)

Invited Talks

AGA 1.1	Wed	14:30–15:30	HS HISKP	**"New Wine into Old Wineskins - Russian Missiles in Ukraine and Their Links to History"** — •Markus Schiller
AGA 4.1	Thu	11:00–12:00	HS HISKP	**Nachweis von Kernwaffentests durch atmosphärische Radioaktivität** — •Martin Kalinowski
AGA 4.2	Thu	12:00–13:00	HS HISKP	**Progress and projects for CTBT monitoring at the German National Data Centre** — •Stefanie Donner
AGA 5.1	Thu	14:30–15:30	HS HISKP	**U.S. Physicists and Nuclear Arms Control During the Next Four Years** — •Frank von Hippel
AGA 5.2	Thu	15:30–16:30	HS HISKP	**How to Eliminate Nuclear-Weapon Programmes - with Physics!** — •Moritz Kütt
AGA 6.1	Thu	17:15–18:15	HS HISKP	**Neutron multiplicity measurement for nuclear disarmament verification** — •Olaf Schumann, Martin Baron, Risse Monika, Theo Köble

Invited Talks of the joint Symposium Nuclear Threats and Challenges – Japanese and German Views (SYNT)

See SYNT for the full program of the symposium.

SYNT 1.1	Mon	16:30–17:00	HS 1+2	**Contributions of Japanese Physicists and the Future** — •Tomohiro Inagaki
SYNT 1.2	Mon	17:00–17:30	HS 1+2	**Nishina Yoshio and Japanese Physicists Early Reactions to the Nuclear Weapons** — •Kenji Ito
SYNT 1.3	Mon	17:30–18:00	HS 1+2	**The work and achievements of scientists in context of International Organisations** — •Martin B. Kalinowski
SYNT 1.4	Mon	18:00–18:30	HS 1+2	**Physicist Contributions to Reducing Current Nuclear Threats and Challenges** — •Moritz Kütt

Invited Talks of the joint Symposium Quantum Science and more in Ghana and Germany (SYGG)

See SYGG for the full program of the symposium.

SYGG 1.1	Tue	11:00–11:05	WP-HS	**Welcome Adress** — •Birgit Münch
SYGG 1.2	Tue	11:05–11:20	WP-HS	**Quantum Education in Ghana** — •Dorcas Attuabea Addo
SYGG 1.3	Tue	11:20–11:45	WP-HS	**Mathematical and Computational Physics Research In Ghana: To Cultivate a Knowledge-Based and Sustainable Development Economy** — •Henry Martin, Henry Elorm Quarshie, Mark Paal, Francis Kofi Ampong, Eric Kwabena Kyeh Abavare, Matteo Colangeli, Alessandra Continenza, Jaime Marian
SYGG 1.4	Tue	11:45–12:10	WP-HS	**Forecasting the Economic Health of Ghana Using Quantum-Enhanced Long Short-Term Memory Model** — •Peter Nimbe, Henry Martin, Dorcas Attuabea Addo, Nicodemus Songose Awarayi
SYGG 1.5	Tue	12:10–12:40	WP-HS	**Quantum Technology with Spins** — •Joerg Wrachtrup
SYGG 1.6	Tue	12:40–13:00	WP-HS	**Renewable Energy Technologies for Rural Ghana: The Role of Appropriate Technology for Tailored solutions** — •Michael Kweku Edem Donkor

Prize and Invited Talks of the joint Awards Symposium (SYAS)

See SYAS for the full program of the symposium.

SYAS 1.1	Thu	14:30–15:10	HS 1+2	**A journey in mathematical quantum physics** — •Reinhard F. Werner
SYAS 1.2	Thu	15:10–15:50	HS 1+2	**Precision Tests of the Standard Model at Low Energies Using Stored Exotic Ions in Penning Traps** — •Klaus Blaum
SYAS 1.3	Thu	15:50–16:30	HS 1+2	**Controlling light by atoms and atoms by light: from dark-state polaritons to many-body spin physics** — •Michael Fleischhauer
SYAS 1.4	Thu	16:30–16:35	HS 1+2	**Quantum history at your fingertips: Launch of the DPG's Quantum History Wall** — •Arne Schirrmacher

Sessions

AGA 1.1–1.2	Wed	14:30–16:00	HS HISKP	**Missiles**
AGA 2.1–2.2	Wed	16:00–17:00	HS HISKP	**Nuclear Archeology**
AGA 3.1–3.1	Wed	17:00–17:30	HS HISKP	**Technology Asessment and Quantum Technologies**
AGA 4.1–4.2	Thu	11:00–13:00	HS HISKP	**Verification I – Comprehensive Test Ban Treaty**
AGA 5.1–5.3	Thu	14:30–17:00	HS HISKP	**Nuclear Weapons, Arms Control and Disarmament**
AGA 6.1–6.2	Thu	17:15–18:45	HS HISKP	**Verification II – Detection and Nuclear Disaramament Verification**
AGA 7	Thu	18:45–19:30	HS HISKP	**Members' Assembly**
AGA 8.1–8.2	Fri	11:00–12:00	HS HISKP	**Nuclear Prolfieration**
AGA 9.1–9.3	Fri	12:00–13:30	HS HISKP	**Verification III – Antineutrino Detection**

Annual General Meeting of the Working Group on Physics and Disarmament

Donnerstag 18:00–19:00 HS HISKP

- Bericht
- Wahl
- Verschiedenes

AGA 1: Missiles

Time: Wednesday 14:30–16:00 Location: HS HISKP

Invited Talk AGA 1.1 Wed 14:30 HS HISKP

"New Wine into Old Wineskins - Russian Missiles in Ukraine and Their Links to History" — •Markus Schiller — ST Analytics München

Missile strikes seem to play a significant role in the Russian invasion in Ukraine. Many different types of missiles have been used by the Russian side since February 2022, most prominent of them the Kinzhal and Zircon hypersonic missiles, as well as the Oreshnik Intermediate Range Ballistic Missile (IRBM). Announced as highly capable state-of-the-art systems, many aspects of those weapons are not new, though. This presentation will try to offer some insights on Russian missile developments on the past, and how those can be linked to the modern systems observed in the Russian war against Ukraine.

AGA 1.2 Wed 15:30 HS HISKP

New Intermediate-Range Missiles in Germany - Developments and Problems — •Jürgen Altmann — Experimentelle Physik III, TU Dortmund

In 2024 the USA and Germany have announced that the US will deploy conventionally armed ballistic and cruise missiles in Germany from 2026, including hypersonic ones. With ranges from 500 to 3,000 km they will threaten tactical and strategic targets deep in Russia. Russia has many similar systems threatening targets in Western Europe with nuclear or conventional warheads. However, in a wider view a US/NATO "deterrence gap" does not exist. New land-based missiles with short flight times can increase Russian fears about preparations for a surprise attack, decreasing crisis stability and creating motives for an accelerated arms race. The talk will discuss technical, military, stability and arms-control aspects

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.

AGA 3: Technology Asessment and Quantum Technologies

Time: Wednesday 17:00–17:30 Location: HS HISKP

AGA 3.1 Wed 17:00 HS HISKP

Implications of Quantum Technologies for international Security — •Juergen Altmann[1] and Götz Neuneck[2] — [1]TU Dortmund, Experimentelle Physik III — [2]IFSH, Universität Hamburg

Quantum sciences enable completely new applications with potential consequences in many societal areas, but also in geopolitics and defense. Future risks are foreseeable in fields such as quantum communication, cryptography, quantum sensors and quantum navigation. Even if many developments are not yet predictable, their social and security policy risks should be discussed in advance. In this talk some potential destabilizing developments and programmes will be identified and mechanisms for risk reduction examined. Experience from the areas of risk technologies, arms export control or preventive arms control should be applied to future destabilising applications.

AGA 4: Verification I – Comprehensive Test Ban Treaty

Time: Thursday 11:00–13:00 Location: HS HISKP

Invited Talk AGA 4.1 Thu 11:00 HS HISKP

Nachweis von Kernwaffentests durch atmosphärische Radioaktivität — •Martin Kalinowski — CTBTO Vienna

Atmosphärische Radioaktivität ist eine von vier Messgrößen, die zur Überprüfung des Vertrages über das umfassende Verbot von Nuklearversuchen eingesetzt werden. Während die anderen Signale für die Ortung von Explosionen geeignet sind, kann nur durch Radioaktivität deren nuklearer Charakter bestätigt werden. Zwischen 1964 und 1996

wurden radioaktive Isotope in der Atmosphäre gemessen, die in zahlreichen Fällen Kernwaffentests zugeschrieben werden konnten, die über viele tausende Kilometer von der Probenahmestelle entfernt waren. Die meisten dieser nuklearen Explosionen ereigneten sich in der Atmosphäre, aber es wurden auch Freisetzungen von radioaktiven Isotopen aus unterirdischen Tests beobachtet. Die Messmethoden entwickelten sich im Laufe der Zeit, und es wurden viele verschiedene Spalt- und Aktivierungsprodukte identifiziert. Die historischen Daten können für die Validierung und Verbesserung von Methoden für die Überwachung der atmosphärischen Radioaktivität im Rahmen des Vertrags über das umfassende Verbot von Nuklearversuchen genutzt werden. Mit dem zu diesem Zweck betriebenen internationalen Überwachungsnetz wurden einige der von der Demokratischen Volksrepublik Korea zwischen 2006 und 2017 durchgeführten Nukleartests nachgewiesen.

Invited Talk AGA 4.2 Thu 12:00 HS HISKP
Progress and projects for CTBT monitoring at the German National Data Centre — •Stefanie Donner — Bundesanstalt für Geowissenschaften und Rohstoffe (BGR) Hannover

The Comprehensive Nuclear-Test-Ban Treaty (CTBT) bans all nuclear explosions underground, in the atmosphere, and under water. The International Monitoring System (IMS) has been established, equipped with sensors for three geophysical waveform technologies: seismology, hydroacoustics, and infrasound (SHI). A fourth technology monitors particulate radionuclides and radioactive noble gases in the atmosphere, supported by atmospheric transport modelling to connect possible detections with potential source.

BGR is the National Data Centre (NDC) for the CTBT in Germany. It cooperates closely with the Bundesamt für Strahlenschutz which operates the radionuclide station at Schauinsland. The NDC sustains own stations as part of the IMS, supports the International Data Centre in Vienna, and conducts research and development projects to support the CTBT.

This talk provides an overview about the structures and processes to globally monitor the complicance with the CTBT. It further provides insights into recent activities and projects of the German NDC, including case studies and showcases for the use of IMS data for civil and scientific purposes.

AGA 5: Nuclear Weapons, Arms Control and Disarmament

Time: Thursday 14:30–17:00 Location: HS HISKP

Invited Talk AGA 5.1 Thu 14:30 HS HISKP
U.S. Physicists and Nuclear Arms Control During the Next Four Years — •Frank von Hippel — Princeton University

Nuclear arms control has been in retreat in the US since 2002 when President Bush Jr. took the U.S. out of the ABM Treaty. President Obama obtained Senate ratification of the New START Treaty (which expires in 2026) only in exchange for a commitment to "modernize" the entire US nuclear arsenal. China*s decision to build hundreds of missile silos has caused Congress to push for reversal of some post-Cold War nuclear reductions. A second Trump Administration may, like the first, be interested in resuming nuclear testing. It remains to be seen whether the US public can be engaged with nuclear weapons policy again, as it was in the early 1980s. The Physicists Coalition for Nuclear Threat Reduction has mobilized to educate Congress about the risks of nuclear war and opportunities to reduce them. We would welcome a similar mobilization in Germany, a member of NATO*s nuclear planning group

Invited Talk AGA 5.2 Thu 15:30 HS HISKP
How to Eliminate Nuclear-Weapon Programmes - with Physics! — •Moritz Kütt — Institute for Peace Research and Security Policy (IFSH)

Within nuclear-armed states, nuclear-weapon programmes include various techno-political structures for nuclear weapon development and production, and preparations for use and threat of use. This presentation will discuss essential steps related to the elimination of these programmes: First, ways to reduce the risk of nuclear escalation; second, ways to support dismantlement of weapon and weapon production facilities; and third, ways to deal with side effects of weapon activities, like environmental contamination caused by production and testing.

The presentation will further discuss examples of how physicists can make valuable contributions to each of these steps. For instance, a technical analysis of missile defense technology helps to reduce nuclear dangers. Physics can also support verification, an important aspect of dismantlement. In this regard, results from a recent study on potential cheating attempts of gamma-spectroscopy measurements are presented, as well as innovative methods to demonstrate the absence of nuclear weapons using cosmic-origin particles. The talk will conclude with an outlook on future research questions to be undertaken, in particular with regard to the remediation of nuclear weapon test effects.

AGA 5.3 Thu 16:30 HS HISKP
The Physics of Effects of Nuclear weapons revisited — •Götz Neuneck — IFSH, University of Hamburg

Since the beginning of the nuclear age which started with the nuclear explosions in Hiroshima and Nagasaki, models and simulations of the effects of nuclear weapons have been undertaken by scientists and institutions. Beyond the material destruction, the societal, radiological, environmental and climatic effects have serious consequences for public health, global socioeconomic systems, agriculture etc. The United Nations proposed to establish an Independent Scientific Panel on the effects of Nuclear war. The talk summarizes the input, the methods and the conclusions of different studies to understand better the severe consequences of nuclear use. Key questions are: Are the earlier studies still compatible with the current possible scenarios? Is there a need for more research on the issue? What are the conclusions of states and relevant international organisations?

AGA 6: Verification II – Detection and Nuclear Disaramament Verification

Time: Thursday 17:15–18:45 Location: HS HISKP

Invited Talk AGA 6.1 Thu 17:15 HS HISKP
Neutron multiplicity measurement for nuclear disarmament verification — •Olaf Schumann[1], Martin Baron[2], Risse Monika[1], and Theo Köble[1] — [1]Fraunhofer INT, Euskirchen — [2]Bundesamt für Strahlenschutz, Berlin

International Partnership for Nuclear Disarmament Verification (IPNDV) aims to explore technologies and procedures to verify the reduction of nuclear weapon arsenals in the future. Within the IPNDV framework, an international measurement campaign was conducted in 2023 at the SCK CEN research center in Mol, Belgium. The goal was to validate or refute if an unknown assembly matches a previously measured template. During the three-week campaign, different techniques were employed by multiple teams. We present our neutron multiplicity measurements, that were taken with two different devices, an Ortec Fission Meter and a Canberra JCC 71 Slab Counter with a list mode electronic. We conclude that neutron measurements are a valuable tool for template validation, but have to be complemented with additional techniques, for example with gamma spectrometry.

AGA 6.2 Thu 18:15 HS HISKP
Neutron detection with a NaIL-detector — •Monika Risse, Theo Köble, and Thorsten Teuteberg — Fraunhofer INT, Euskirchen, Germany

Neutron detection is of crucial importance in the fields of verification and disarmament due to the difficulty of shielding neutrons compared to gamma radiation. Due to the global shortage of ^{3}He the exploration of alternatives are necessary. One promising approach is the use of ^{6}Li, which captures neutrons through the reaction ^{6}Li(n,t)α.

This study introduces the NaIL detector, which incorporates ^{6}Li into sodium iodide (NaI), a proven material for gamma detection. Gamma and neutron radiation can be differentiated using pulse shape analysis. Measurements were conducted with various neutron sources to evaluate the performance of the detector, including its ability to detect sources producing radiation fields just above background levels. Further investigations examined the impact of moderator materials (e.g. HDPE), the gamma spectrum resolution, and the overall detection efficiency. NaIL results were compared to those from ^{3}He-based detectors.

AGA 7: Members' Assembly

Time: Thursday 18:45–19:30 Location: HS HISKP

All members of the Working Group on Physics and Disarmament are invited to participate.

AGA 8: Nuclear Prolfieration

Time: Friday 11:00–12:00 Location: HS HISKP

AGA 8.1 Fri 11:00 HS HISKP

Weapon Usability of High-Assay Low-Enriched Uranium (HALEU) — •Christopher Fichtlscherer — IFSH Hamburg, Germany — RWTH Aachen, Germany

Advanced nuclear reactor designs frequently explore using High-Assay Low-Enriched Uranium (HALEU) fuels. While current civilian power reactors use uranium fuels enriched up to 5% U-235, HALEU can contain up to 20%. Still falling into the category of low-enriched uranium (LEU), HALEU requires safeguards activities similar to typical reactor fuel, assuming that the material is not at all usable in nuclear weapons. In parallel to the increased interest in HALEU fuel deployment, a debate has recently started questioning that assumption. Kemp et al. claim in a 2024 published Science article *"that quantities ranging from several hundred kilograms to about 1000 kg of 19.75% HALEU could produce explosive yields similar to or greater than that of the 15 kilotons of TNT equivalent bomb that the United States dropped on Hiroshima, Japan, at the end of World War II."* The authors assert that their yield assumptions are based on the Serber-Bethe-Feynman formula; however, they do not provide any details about assumptions or calculations to support this claim. This presentation contributes to that debate by examining the weapon-usability of HALEU at different enrichment levels in detailed calculations relying only on publicly available information.

AGA 8.2 Fri 11:30 HS HISKP

Nonproliferation and Fusion Power — •Matthias Englert — Öko-INstitut e.V., Rheinstr. 95, 64295 Darmstadt

Fusion energy systems, while avoiding the use of fissile materials such as highly enriched uranium and plutonium, still pose certain proliferation risks. Key concerns include the diversion of tritium for military purposes, the production of weapon-grade plutonium using fusion neutrons, and the dual-use potential of laser/inertial confinement fusion facilities for nuclear weapons development. This talk examines these risks with a focus on material monitoring challenges, the technical feasibility of plutonium breeding in fusion reactors, and the role of advanced experimental and computational methods in circumventing nuclear test bans. Strategies for mitigating proliferation risks include the integration of safeguards-by-design in early-stage reactor concepts, international standardization of monitoring frameworks, and fostering dialogue between fusion research and nonproliferation communities. Given the increasing global interest in fusion energy, these measures are critical to ensuring that its development remains secure and aligned with peaceful objectives.

AGA 9: Verification III – Antineutrino Detection

Time: Friday 12:00–13:30 Location: HS HISKP

AGA 9.1 Fri 12:00 HS HISKP

nuSENTRY: antineutrino monitoring for future advanced reactors — •Yan-Jie Schnellbach — TU Darmstadt

In recent years, renewed interest in nuclear power as low-carbon source of electricity has lead to significant investment and build ambitions in so-called small modular reactors (SMRs). These reactors are smaller versions of current light water-moderated reactor as well as more exotic concepts. The key feature of modularity aims at mass production of reactor units, which potentially imposes new demands on existing non-proliferation and safeguards regimes. Additionally, advanced reactor concepts introduce ideas such as higher enrichment fuel (high-assay low enriched uranium - HALEU) or bulk fuels (pebble fuel, liquid fuel).

Monitoring reactor operations and concepts via their antineutrino emissions has been demonstrated for large conventional nuclear power plants, with several active R&D projects globally. The nuSENTRY project and group is now investigating the transferability of these technologies to future SMR and naval reactor scenarios. Upcoming detector technologies will be studied to determine their feasibility as antineutrino-based reactor safeguards. Finally, in addition to the antineutrino signal, particle signatures, such as neutron flux or cosmic muon information will also be considered as complementary data stream. Previous work on spent fuel safeguards will be presented and planned investigations into advanced reactor monitoring scenarios will be introduced.

AGA 9.2 Fri 12:30 HS HISKP

Feasibility of Safeguards-oriented Muography with an Antineutrino Detector — •Sarah Friedrich[1], Malte Göttsche[2], Stefan Roth[3], and Yan-Jie Schnellbach[1] — [1]Technische Universität Darmstadt, Darmstadt, Germany — [2]PRIF- Leibniz-Institut für Friedens- und Konfliktforschung, Frankfurt am Main, Germany — [3]RWTH Aachen University, Aachen, Germany

The Treaty on the Non-Proliferation of Nuclear Weapons (NPT) requires non-nuclear weapon states to exclusively utilize nuclear materials and technologies for peaceful purposes. It also permits the International Atomic Energy Agency (IAEA) to establish safeguards for the purpose of verifying compliance with the NPT's obligations. In the context of emerging reactor designs, particularly the development of Small Modular Reactors (SMRs), the enhancement of existing safeguards and the examination of novel safeguards are of particular importance. By using the example of a container loaded with spent nuclear fuel, this simulation-based feasibility study demonstrates that the use of cosmic muons makes it possible to obtain information about a container with the muographic application of an antineutrino detector. Moreover, the energy of the muons can be analyzed to ascertain the contents of the container, particularly the materials within, by determining their density. The insights gained from this analysis will be further developed to apply them to the context of SMRs, integrating them with other verification technologies.

AGA 9.3 Fri 13:00 HS HISKP

Drift parameter simulation of TMS TPC prototype for antineutrino detection — •Hannah-Lea Tegtmeyer[1], Malte Göttsche[2], Stefan Roth[1], and Yan-Jie Schnellbach[3] — [1]III. Physikalisches Institut B, RWTH Aachen — [2]Peace Research Institute Frankfurt (PRIF) — [3]TU Darmstadt

Antineutrino detectors can be utilized for non-intrusive verification

measures, as they can be deployed externally or atop nuclear facilities with minimal disruption. To improve their utility, the development of portable detectors is critical. Time projection chambers (TPCs) designed to detect neutrinos and antineutrinos typically use liquid argon as a dense detection medium, but its requirement for cryogenic cooling presents logistical challenges. Furthermore, liquid argon is not well-suited for detecting antineutrinos in the energy ranges relevant for spent fuel (<2.2 MeV) or reactor monitoring (<8 MeV). In the alternative drift medium Tetramethylsilane (TMS), which contains protons in the molecule, antineutrinos can react via the inverse beta decay. In addition TMS has more relaxed cooling requirements near room temperature. This research involves simulating the drift parameters of a prototype TPC filled with TMS, aiming to identify the parameter ranges that support reasonable energy resolution and potentially directional sensitivity. The simulations help evaluate whether TMS is a viable alternative to traditional detection media, guiding the optimization of the prototype*s design and performance.