Princeton School on Science and Global Security

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The Princeton School on Science and Global Security

The Princeton School on Science and Global Security, launched in 2020, trains next-generation scientists and engineers from around the world in technical perspectives on understanding, reducing, and ending the threat from nuclear weapons. The goal is to provide skills and insights that participants can use in their own research, encourage and inspire them to investigate new ideas to advance global security and a safer and more peaceful world and to foster an international community of such researchers. The School is organized by Princeton University's Program on Science and Global Security (SGS), part of the School of Public and International Affairs.

The meeting includes presentations by invited graduate students, post-doctoral researchers and established researchers on topics such as nuclear weapon effects, space security, nuclear proliferation, artificial intelligence, the Treaty on the Prohibition of Nuclear Weapons, and the role of scientists.

History

The Princeton School on Science and Global Security traces its origins to the international School on Science and World Affairs organized by the forerunner of the Program on Science and Global Security and the Moscow Institute of Physics and Technology held over eight days in September 1989 outside Moscow. Princeton hosted the second International Summer School on Science and World Affairs in August 1990. The schools focused on nuclear disarmament and global environmental issues. The two schools grew out of discussions between the U.S. physicist Frank von Hippel and the Soviet physicist Roald Sagdeev about the lack of a younger generation of Russian scientists knowledgeable about arms control issues. These discussions also led to the publication of a new international journal, *Science & Global Security*, with an initial editorial board of U.S. and Soviet scientists.

The third Summer School was hosted in Moscow by the newly established Center for Arms Control, Energy, and Environmental Studies at Moscow Institute of Physics and Technology in 1991.

The 1992 Summer School was held in Shanghai, hosted by the Center for American Studies (CAS) at Fudan University. It was organized together with the Union of Concerned Scientists (UCS) which took lead responsibility for future meetings. These meetings became known as the International Summer Symposium on Science and World Affairs. Since the first meeting in 1989, these gatherings have hosted over 700 scientists and researchers from almost 50 countries.

Program on Science and Global Security

Princeton University's Program on Science and Global Security (SGS), based in the School of Public and International Affairs, conducts scientific, technical and policy research, analysis and outreach to advance national and international policies for a safer and more peaceful world. The Program was founded in 1974 by Harold Feiveson (1935–2025) and Frank von Hippel. It marked its 50th anniversary in 2024.

Throughout its history, SGS has worked on nuclear arms control, nonproliferation, and disarmament to reduce the dangers from nuclear weapons and nuclear power. The control and elimination of fissile materials (the key ingredients for nuclear weapons) is a major part of the SGS agenda. SGS works to understand and reduce the risks from nuclear weapons and the strategies, postures, forces and policies of the nine nuclear armed states. SGS also helps develop confidence-building measures to reduce the risks of crisis, arms racing and nuclear weapons use in the U.S.-NATO-Russian region, South Asia, the Middle East, East Asia, and the Pacific. SGS also works on satellite imagery, nuclear weapon and nuclear war effects, proliferation risks of nuclear and fusion energy, and dual-use aspects of AI and robotics.

SGS does research to support the 2017 United Nations Treaty on the Prohibition of Nuclear Weapons and the goal of the verified and irreversible elimination of all nuclear weapons and weapon programs. SGS is home to *Science & Global Security,* the leading academic peer-reviewed journal for technical arms-control analysis. The journal covers nuclear, biological, chemical, space, and cyber technologies and programs and related security issues. Its goals are to help develop the technical basis for new policy initiatives to reduce the risks from these technologies to international peace and security and to provide a resource for further scholarship and policy analysis.

SGS provides training opportunities for post-doctoral and senior scientists interested in science and security policy. It has helped train technical nuclear arms control and nonproliferation researchers from around the world.

Participants and Abstracts

Anja Beck (she/her)
Massachusetts Institute of Technology

Detecting Anomalies in Nuclear Programs with Particle Physics Methods

Abstract. Nuclear weapon production involves a complex, multi-stage process that generates physical, logistical, and behavioral signatures. These small signatures are diluted in the noisy background of messy economic and environmental data on a global scale, scattered across time and space. Flagging rare deviations from a not entirely well-known baseline in large and high-dimensional data is the task of modern high-energy particle physics. This talk will explore how anomaly detection methods developed for the large datasets in particle physics can be applied to characterize deviations from normal activity across the nuclear weapons production pipeline. These methods may be applied on nuclear programs to flag anomalous activity by considering information such as satellite imagery, maritime traffic, trade logs, or power consumption patterns.

Biography. Anja Beck is a postdoctoral researcher at the MIT Laboratory for Nuclear Science working on studies for the proposed future circular collider and the application of machine learning in particle physics. After undergraduate studies in Germany, Sweden, and France, she completed her PhD at the University of Warwick working on the LHCb particle physics experiment at CERN. Following her interest in political questions, she worked in the German parliament after her PhD and before joining MIT. Anja is interested in exploring how she can use her experiences and skills to create positive change on an larger scale.

Annie Berens
Lawrence Livermore National Laboratory

Rapid Inventory Generation for Pebble-Bed Reactors Operating at Equilibrium for Detection of Misuse

Abstract. Pebble bed reactors (PBRs) are a type of advanced reactor that utilizes a pebble fuel form, different from conventional light water reactors (LWRs). China has built and operated two PBRs, and a PBR designed by Kairos Power became the first non-LWR reactor in the U.S. to be issued a construction permit. One of the concerns of PBRs is the potential for diversion and misuse of nuclear material due to the millions of fuel pebbles that circulate through the core during operation. The timely detection of diversion and misuse is important for the application of International Atomic Energy Agency safeguards to PBRs. After the generation of pebble inventories, a simulated burnup monitoring system (BUMS) can be used to determine the statistical distribution of the burnup of pebbles being discharged from the reactor, thereby be used to detect the possible diversion or misuse of nuclear material.

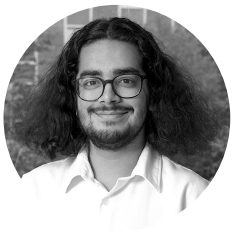
Biography. Annie Berens is a Postdoctoral Researcher at Lawrence Livermore National Laboratory focusing on advanced reactor modeling for nonproliferation. She received her PhD in Nuclear Engineering from the University of Tennessee, Knoxville, for her dissertation titled "Development and Applications of Jump-In Equilibrium Modeling Methods for Pebble-Bed High-Temperature Gas-Cooled Reactors" in May 2025.

Thomas Boland (he/him)
Forschungszentrum Jülich

Muon Tomography for the Safeguards Re-Verification of Spent Nuclear Fuel Casks.

Abstract. Nuclear safeguards are applied on spent nuclear fuel in dry interim storage facilities through containment and surveillance measures that ensure continuity of knowledge. However, in the unlikely event of temporary failure of applied measures, knowledge needs to be restored. The thick cask walls shield most of the radiation emitted by the fuel, posing a significant challenge for the non-destructive assay methods that are currently in use by the IAEA. To address this challenge, muon tomography is investigated as a novel technique for the re-verification of spent nuclear fuel casks. This presentation demonstrates how the interior of a cask can be reconstructed by measuring the scattering and absorption of cosmic muons. This enables the re-verification of the cask integrity and the detection of potential nuclear material diversion.

Biography. Thomas Boland is a physicist from Belgium, where he studied nuclear physics at KU Leuven and completed his master's thesis at the Belgian Nuclear Research Center SCK CEN, working with machine learning models for the safeguards verification of spent nuclear fuel assemblies. He is currently a PhD student in the division of Nuclear Safeguards and Security of the Institute for Nuclear Waste Management at Forschungszentrum Jülich, developing software for the reconstruction of spent nuclear fuel casks from muon tomography measurements.



Arjun Chhabra (he/him)
Princeton University

Characterizing Cislunar Environmental Outcomes for Orbital Debris Mitigation Policy Development

Abstract. Forecasted growth in cislunar space activity over the coming decades necessitates development of technical standards and policy directives to mitigate risks due to the generation and proliferation of orbital debris. Such mitigative measures must contend with various technical and sociological uncertainties in the exact pathway of cislunar growth, potential shifts in the public-private frontier of space activity, and the addressal of gaps in existing governance frameworks. We thus propose a framework for the classification of cislunar environmental outcomes, which could arise from various cislunar growth pathways and are characterized by a set of technical characteristics and associated relational dynamics between key space actors. By rigorously characterizing attributes of each class of outcomes, our work provides a means of standardizing the methodology by which the robustness and efficacy of proposed policy directives in the face of uncertainties in the long-term growth pathways of space activity in the cislunar domain.

Biography. Arjun is a PhD Candidate in Mechanical and Aerospace Engineering at Princeton University, working with Professor Ryne Beeson. His work focuses on jointly addressing challenges across the technical and policy aspects of cislunar orbital sustainability. Prior to his time at Princeton, Arjun earned a Bachelors of Applied Science in Engineering Science from the University of Toronto.

Yacobo Damizia (he/him)
College of William & Mary

Safeguarding Fusion's Future: International Governance, Tritium Control, and Nonproliferation

Abstract. Advances in fusion energy raise urgent questions about international governance and nuclear non-proliferation. Unlike nuclear fission, fusion technology currently operates outside traditional regulatory frameworks; the Non-Proliferation Treaty (NPT), Nuclear Suppliers Group, and existing International Atomic Energy Agency (IAEA) safeguards do not explicitly address fusion facilities or fuels, resulting in an inadequate patchwork of voluntary measures. This creates a critical governance gap as fusion power plants could be exploited to breed fissile materials or divert tritium for weapon programs. My presentation outlines the necessity for a new international protocol, potentially a "Second Additional Protocol" under the IAEA, to incorporate fusion facilities into appropriate verification mechanisms. Recommended measures include real-time accounting of tritium inventories, classification of sensitive fusion technologies for controlled export, and strengthening international collaboration via organizations such as the IAEA and OECD/NEA. Preventing the weaponization of fusion is not only a legal obligation but also an ethical imperative.

Biography. Yacopo Damizia is a Postdoctoral Research Associate at William & Mary, based at the MAST-U tokamak in the UK. He completed his PhD at the University of Liverpool and UKAEA, where he led experiments on ion temperature diagnostics in the divertor region of MAST-U. His research focuses on plasma transport and fueling in fusion devices. In parallel, he has developed a strong interest in nuclear non-proliferation and disarmament, participating in the Princeton Science and Global Security School, ESARDA, and SIPRI programs. He aims to bridge science and policy by contributing technical insight to global nuclear security efforts.

Elizabeth Decoteau
George Washington University

Scintillating Metal-organic Frameworks for Optical Detection of Noble Gas Radionuclides in Nuclear Forensics

Abstract. The Department of Homeland Security identifies prompt signal analysis and the collection of post-detonation materials as key technical mission areas in nuclear forensics. Nuclear fission of both uranium and plutonium yields a mixture of radioactive products, some of which are noble gases. These gaseous fission products can escape into the environment during nuclear events as they are more difficult to contain than fission products in other states. Monitoring these radioactive gases is essential not only for detecting nuclear reactor operational failures but also in the field of nuclear forensics, where the elevated presence of these anthropogenic radionuclides can serve as a direct indicator of illicit nuclear activities. In this presentation, I will discuss the field of nuclear forensics including its current opportunities and challenges. I will also discuss my work on developing metal-organic frameworks (MOFs) for the optical detection and selective capture of radioactive noble gases.

Biography. Elizabeth Decoteau is a fourth year student in the chemistry PhD program at George Washington University. She grew up in a small town in central Pennsylvania where her interest in nuclear science first developed during her undergraduate research at Bloomsburg University. There, she was introduced to the interesting and largely unexplored properties of the f-elements – an area that has shaped her research ever since. Following graduation, she hopes to pursue a career in nuclear policy by integrating her technical knowledge of nuclear chemistry into the strategies and approaches utilized in policymaking.

Christoper Fichtlscherer (he/him)
Massachusetts Institute of Technology

How Believable Are Nuclear Warhead Radiation Signatures?

Abstract. Nuclear weapons inevitably emit photons and neutrons, resulting from the radioactive decay of fissile materials within them. Many proposed technologies for the verification of nuclear disarmament make use of these emissions as warhead signatures to confirm or disprove that an object is a warhead. However, such verification poses significant challenges: nuclear-armed states demand assurances that verification methods do not reveal sensitive information. As a result, systems often resort to low-resolution detectors and compare measured emissions against pre-recorded templates. For effective and trustworthy confirmation, it is important to know whether signatures are stable over time and unique. This contribution shows results from an in-depth analysis, which finds that natural ageing processes can push the photon emissions outside acceptance windows, and that it is possible to find different hoax objects whose emissions could mimic real warheads. I will also discuss initial steps toward overcoming these vulnerabilities using a genetic algorithm.

Biography. Christopher Fichtlscherer is a postdoctoral researcher in MIT's Department of Nuclear Science and Engineering. He is interested in using insights from applied nuclear physics and technology to promote nuclear arms control, nonproliferation, and international peace and security. His current project explores potential vulnerabilities of ICBM forces. Prior to joining MIT, he worked at the Institute for Peace Research and Security Policy in Hamburg and completed a PhD in physics in 2025 (RWTH Aachen) and a Master of Science in Mathematics (University of Hamburg). He was a visiting graduate student at Princeton's Program on Science and Global Security

Leonard Günzel (he/him)
Norwegian University of Science and Technology

Autonomous Underwater Vehicles and Their Impact on Strategic Stability and Nuclear Deterrence

Abstract. For much of the modern era, underwater research has been driven not only by scientific curiosity but also by military strategy. Submarines—especially in the nuclear context—have played a critical role in enabling stealthy first- and second-strike capabilities, operating independently of terrestrial conflict. Today, the underwater domain remains crucial for nuclear deterrence but has also gained importance in conventional and hybrid warfare, as highlighted by the Nord Stream 2 pipeline attack. Advances in computing and battery technology have further accelerated the rise of Autonomous Underwater Vehicles (AUVs), including missile-carrying and even nuclear-powered prototypes fielded by countries such as the United States and Russia. While AUVs mirror the geopolitical logic of submarines, they also introduce new constraints and opportunities. These developments underscore the need for deeper analysis of how autonomy alters the balance of power in the underwater domain and its implications for future conflict.

Biography. Leonard Günzel is a PhD candidate in underwater robotics at the Norwegian University of Science and Technology (NTNU), where his research focuses on situational awareness for underwater robots. His work focuses on improving autonomy by combining acoustic and optical perception with machine learning methods. Leonard has been trained in marine and electrical engineering and has worked as a scientific assistant at more than seven leading marine institutions. He is deeply engaged in the ethical dimensions of technology development in collaborations with organizations such as the Stockholm International Peace Research Institute (SIPRI) and the United Nations Office for Disarmament Affairs (UNODA).

Robin Mentel (he/him)
Technische Universität Darmstadt

The Loophole of Non-proscribed Military Use of HEU in Naval Reactors: Can Antineutrino-monitoring Prevent Nuclear Proliferation?

Abstract. Recent plans for the acquisition of nuclear-powered submarines by non-nuclear weapon states have opened a new vector for potential nuclear proliferation. The sale of conventionally-armed, nuclear-powered attack submarines by the US and the UK to Australia under the AUKUS agreement is one such example, where article 14 of the Comprehensive Safeguards Agreement would waive requirements for safeguards on the highly enriched uranium in submarine reactors. Non-intrusive methods using the antineutrinos emitted from the reactors could help preventing the diversion of nuclear material from the reactor. In this talk, I will present my research on developing such a method by simulating naval reactors with the Monte Carlo code OpenMC, and the subsequent detection of the emitted antineutrinos in an organic ionisation chamber using the Monte Carlo platform Geant4.

Biography. Robin Mentel is a postdoctoral researcher at Technische Universität Darmstadt, developing methods to safeguard naval reactors using antineutrino emission. He received a BSc in Physics in Marburg, Germany, and a Msc in astronomy in Leiden, Netherlands. In 2025, he concluded his PhD at University College Dublin, modeling the immediate environment of young stars using high-resolution spectroscopy. Moved by the second Russian invasion of Ukraine in 2022, he reoriented his career path to the field of nuclear arms control.

Umma Nabila
University of Michigan

Learning with Less: AI-Driven Solutions for Data-Limited Challenges in Nuclear Security and Safeguards

Abstract. Leveraging Artificial Intelligence (AI) to automate systems has the potential to revolutionize global security strategies—particularly in nuclear safeguards, arms control, and non-proliferation monitoring. To date, research applications include satellite imagery analysis of nuclear facilities, automated interpretation of radiation signatures, and nuclear material accounting. A key challenge to realizing effective AI solutions in these arenas is the scarcity of ground-truth examples for training networks—especially in scenarios involving rare, costly, or sensitive nuclear activities. To address this limitation, this presentation presents an approach that uses generative AI models to produce realistic synthetic satellite imagery and radiation spectra, that both enhance detection performance and enable testing against potential deception. In parallel, Active Learning (AL) techniques further enhance AI-driven safeguards by allowing models to selectively query experts for the most informative data points. This maximizes learning efficiency in data-limited environments and supports real-time anomaly detection. This presentation will explore the strength of these techniques through case studies and discuss key technical and ethical challenges—as well as potential solutions—for deploying these tools responsibly to advance non-proliferation and reduce the threat of nuclear weapons.

Biography. Umme Mahbuba Nabila is a PhD student in the Nuclear Engineering & Radiological Sciences department at the University of Michigan, Ann Arbor, and a member of the Artificial Intelligence and Multiphysics Simulations (AIMS) lab led by Professor Majdi Radaideh. Her research focuses on applying AI/ML to autonomous control systems and digital twins for nuclear reactors. Nabila holds BSc and MSc degrees in Nuclear Engineering from the University of Dhaka, and has interned at Idaho National Laboratory, Oak Ridge National Laboratory and CERN.

A. Bariş Özgüler
University of California, Berkeley

QuantumVeritas: Quantum-Enhanced Verification Framework for Nuclear Arms Control

Abstract. This presentation will introduce *QuantumVeritas,* a new framework that uses advances in quantum technology to strengthen nuclear arms control. The system combines secure communication tools, and privacy-preserving methods into a single platform for treaty verification and export monitoring. Quantum sensors can detect subtle signatures of nuclear materials, while secure links ensure that inspection data cannot be intercepted or altered even by future quantum computers. Privacy tools allow inspectors to confirm items without exposing sensitive design details, protecting national security interests. These results feed into simulations that model how inspectors, exporters, and potential violators might interact across global supply chains. This talk will outline the framework and show how it helps policymakers and scientists test different strategies for inspections, licensing, and security rules under existing and future nuclear agreements.

Biography. Bariş Özgüler is a quantum physicist and technologist. He holds a PhD in Theoretical Physics from the University of Wisconsin–Madison and has conducted research at leading universities, national laboratories, and quantum technology companies. He is the founder of a stealth startup and an MBA candidate at UC Berkeley specializing in quantum security. Dr. Özgüler is passionate about advancing his knowledge of security policy frameworks and their intersection with technology.

Christine Ploen (she/her)
Old Dominion University

PAINT: A Public Dashboard for Open-Source Nuclear Activity Monitoring

Abstract. International, treaty-based monitoring systems are essential for tracking nuclear activities, but these systems often are opaque to the public and limited in scope to state actors. As a solution to democratize nuclear situational awareness, this presentation introduces The Public Access Initiative for Nuclear Transparency (PAINT). This proposed open-source project is a platform for aggregating and visualizing nuclear-relevant data from public sources. PAINT will enable real-time analysis of open-source indicators — including crowdsourced radiation data, environmental and atmospheric sensors, news, and satellite imagery. This presentation will outline initial development directions, highlighting technical challenges as well as considerations for designing a platform accessible to both non-expert users and policy stakeholders. Our aim is not to confirm nuclear events independently, but rather to synthesize disparate signals into transparent, interpretable trends that inform public dialogue and complement institutional analysis. PAINT ultimately explores how distributed, public-facing infrastructure can enhance global security through transparency and scientific engagement.

Biography. Christine Ploen is an experimental nuclear physics graduate student at Old Dominion University with the Neutral Particle Spectrometer collaboration at the Thomas Jefferson National Accelerator Facility. Her research focuses on nuclear femtography to map the internal structure of atomic nuclei. She earned her bachelor's degree in physics with a minor in mathematics from the University of Connecticut. Christine also serves as a graduate student representative in the Jefferson Lab Users Group, advocating for the scientific and professional development of early-career researchers. Her broader interests include data transparency, open-source tools, citizen science, and technical innovation to strengthen individual and global security.

Eli Sanchez (he/him)
Massachusetts Institute of Technology

Seeing Through "Transparent Oceans" — What it Would Cost to Preemptively Disarm the U.S. Fleet of Ballistic Missile Submarines

Abstract. Ballistic missile submarines (SSBNs) are widely believed to be invulnerable to disarming strikes due to their weak detectable signatures and the large areas within which they patrol. Recently, however, a growing number of analysts have argued that several strands of emerging technology may render SSBNs vulnerable to disarming strikes. These include novel sensing modalities; uncrewed autonomous vehicles; and advanced computing techniques, particularly artificial intelligence.This study first conducts a survey of the sensing technologies cited in this literature and assesses their capabilities for SSBN detection. It then builds a model of hypothetical campaigns to preemptively destroy SSBNs employing the emerging technologies cited above. From this, the amount of military hardware required for such campaigns is estimated. The costs of this hardware are estimated and found to far exceed the financial resources available to modern national actors, suggesting that current technological trends are unlikely to undermine SSBN survivability.

Biography. Eli Sanchez grew up in Smithville, TX. He received a bachelor's degree in Chemistry from the University of Texas at Dallas. He then interned at Oak Ridge National Laboratory, where he used computational models to study the human health effects of radiation exposure. He received a PhD from Nuclear Science and Engineering Department at MIT. His doctoral research assessed the implications of hypersonic weapons for great power strategic stability. He is currently a postdoctoral researcher at the Security Studies Program at MIT, where he studies the potential for emerging technologies to increase the vulnerability of ballistic missile submarines.

Elena Štefancová (she/her)
Comenius University, Bratislava

Transparent AI for Nuclear Risk Reduction: An Interface Between Technology and Policy

Abstract. Artificial intelligence is increasingly integrated into systems that support decision-making, including security and nuclear weapons infrastructure. However, the opacity of many modern AI models poses significant risks, especially in high-stakes contexts involving deterrence, escalation, or early warning systems. This presentation explores how the principles of trustworthy AI—such as accountability, transparency, and explainability—can be applied to enhance the safety and verifiability of technologies relevant to global security. I will outline technical methods to improve the transparency and reliability of AI systems. I will also discuss the need for interdisciplinary collaboration between AI developers, policy analysts, and security experts. By contributing technical approaches while keeping an eye on public good, we can encourage the responsible integration of AI into global security strategies and foster informed dialogue at the intersection of computation and disarmament.

Biography. Elena Štefancová is a PhD researcher in Information & Computer Science with a focus on explainable and trustworthy AI, particularly in recommender systems. Her work spans academia and industry, including a research role at the University of Colorado Boulder as a recipient of the Fulbright Award. She previously interned at CERN, where she contributed to data systems critical to nuclear research. She also actively contributes to digital public services and higher education quality assurance across Europe. Elena hopes to continue applying this interdisciplinary background to bridge AI, data science, and safety-critical domains.

Liska Suckau
Peace Research Institute Frankfurt

Bye Bye State? Crowdsourcing Defense Assets

Abstract. The rise of digital technologies has transformed how civilians engage in conflict, both on and off the battlefield. Digital platforms now shape communication, information flow, and even material realities of war. In Ukraine, volunteer networks have created supply chains for small drones, shells, and armament accessories, often leveraging additive manufacturing (3D printing) to rapidly develop and deliver military technology. Such practices highlight how globally connected, non-commercial actors directly contribute to warfare. So far, little systematic attention has been given to these non-commercial unconventional forms of technical material support. This project aims to investigate how crowdsourcing and democratized innovation enable diverse political actors to convert knowledge into irregular warfare tools, shaping both military capabilities and civil-military relationships. The main focus of the presentation is on off-the-shelf dual-use technologies developed by civilian actor networks for military use, and how they alter and affect military strategies and battlefield realities.

Biography. Liska Suckau is a researcher at the Peace Research Institute Frankfurt (PRIF) working in the Cluster for Natural and Technical Science Arms Control Research. At PRIF, she examines emerging disruptive technologies, their technical limitations, and role in warfare. Liska's main interests are the impact of off-the-shelve and open-source technology on political violence and their innovation. Currently she is drafting a PhD project to examine this nexus in-depth. She holds both bachelor degree in mechanical engineering from TU Dresden, and political science from University of Amsterdam, and a master in war and peace studies from Leiden University, the Netherlands.

Shu Xu (he/him)
Rutgers University

Impacts of Nuclear War on Global Vegetation and Human Health from Enhanced Surface Ultraviolet Radiation

Abstract. Nuclear war simulations that inject soot from burning cities into the stratosphere would reduce stratospheric ozone, leading to increased surface ultraviolet (UV) radiation that can damage terrestrial vegetation and crops, impair ocean microorganisms that support the marine food chains, and increase human health risks including skin cancer and cataracts. This presentation explains the physical and chemical processes driving ozone loss, UV increases, and the implications for photosynthesis, ecosystems, and human health. We examine scenarios of an India-Pakistan nuclear war and of a larger U.S.-Russia war involving higher yield nuclear weapons producing much more soot. Simulations indicate reductions in global biomass, excess annual UV-related mortality across major nations, including the U.S., Russia and China.

Biography. Shu Xu is a second-year PhD student in the Atmospheric Sciences Graduate Program at Rutgers University. He earned his Bachelor's degree in Meteorology from the University of Science and Technology of China. His research examines how climate change affects terrestrial vegetation and human health, with a focus on stratospheric aerosol climate intervention and nuclear war scenarios. In recognition of his academic performance during his undergraduate studies, he was awarded the Geoscience Advancement Scholarship in 2023, as well as the Zhao Jiuzhang Talent Class Scholarship in 2020, 2021, and 2022.

School Lecturers & Organizers

Sara Al-Sayed
Union of Concerned Scientists

Sara Al-Sayed is a Kendall Fellow at the Global Security Program, Union of Concerned Scientists. Her work focuses on the implications of the fusion of artificial intelligence with commercial satellite imagery for nuclear stability. Before joining UCS, she was Postdoctoral Research Associate at Princeton University's Program on Science and Global Security. Her research there focused on technologically-enabled efforts by civil society to monitor nuclear weapons activities. She received her BSc degree from the German University in Cairo, Egypt, MSc degree from Universität Ulm, Germany, and PhD degree from Technische Universität Darmstadt, Germany—all in communications engineering. She also holds an MA in philosophy of technology from Technische Universität Darmstadt.

Leyatt Betre
Princeton University

Leyatt Betre is an independent scholar and Research Collaborator with Princeton's Program on Science and Global Security. Her work explores state-science entanglements in the nuclear age, looking at American science and the evolution of U.S. nuclear force posture and arms control, as well as disarmament advocacy and non-alignment in the Global South. She holds a PhD in Security Studies from Princeton (2022) and held predoctoral and postdoctoral fellowships, respectively, with Harvard's Managing the Atom Project and Stanford's Center for International Security and Cooperation. She received her SB degree in Physics and Political Science from MIT.

Alexandra Bodrova (she/her)
Princeton University

Alexandra Bodrova is a 5th-year PhD student in Mechanical and Aerospace Engineering at Princeton University, where she is affiliated with the Program on Science and Global Security. Her research explores the safeguarding of robotics and AI against dual-use dilemmas. Her previous research, conducted in Princeton's Intelligent Robot Motion lab, centered on developing generalization algorithms for machine learning as applied to robotics. Originally from Moscow, Russia, she earned her Bachelor of Science in Mechanical and Civil Engineering from the California Institute of Technology (Caltech). Alexandra received the Gordon Y.S. Wu Fellowship and the Henry Ford II Award for academic excellence.

Spencer Cohen
The New York Times

Spencer Cohen is a journalist in New York, working at The New York Times on the Opinion page. In 2025, Cohen was part of the team named Pulitzer finalist for "At the Brink," a series on the nuclear threat. Previously, he reported on American breaking news for The Asahi Shimbun, Japan's second-largest paper, following graduate work at the University of Tokyo. Cohen received a bachelor's in history from Columbia University.

Roohi Dalal
American Astronomical Society

Roohi Dalal is a Research Collaborator with SGS, and the Deputy Director of Public Policy at the American Astronomical Society. She received her PhD in Astrophysical Sciences in 2024 from Princeton University. Roohi was a Postdoctoral Fellow at the Outer Space Institute and University of British Columbia. She has served as Vice Chair of the American Astronomical Society's Committee for Protection of Astronomy and the Space Environment. She was also a Next-Generation Fellow of the Physicists' Coalition for Nuclear Threat Reduction. Prior to her PhD studies at Princeton, Roohi received her Bachelor of Science in Astrophysics and History from the California Institute of Technology, and was a Fulbright Scholar at Leiden University. At Caltech, she helped found the Women in Physics, Math and Astronomy organization, and at Princeton she served as President of the Women in STEM Leadership Council.

Julia Georgiana (she/her)
Princeton University

Julia is the SGS Program Manager, overseeing the day-to-day operations and financial processes of the Program. Since joining Princeton University in 2017, Julia has worked as the Graduate Program Administrator for the Department of Politics and as Study Abroad Coordinator in the Office of International Programs. Previously, Julia worked at various universities, including Rutgers, where she held responsibilities for student affairs and university advancement and donor relations. Julia has an undergraduate degree in Business Management from St. John's University, New York, and a graduate degree in Higher Education Administration from Northeastern University.

Alex Glaser (he/him)
Princeton University

Alexander Glaser is a professor in the School of Public and International Affairs and in the Department of Mechanical and Aerospace Engineering. Alex has been co-directing the Program on Science and Global Security since 2016. For Princeton's work on nuclear warhead verification, Foreign Policy Magazine selected him as one of the 100 Leading Global Thinkers of 2014. In September 2020, Alex was elected a Fellow of the American Physical Society. Alex holds a PhD in physics from Darmstadt University, Germany.

Lisbeth Gronlund
Massachusetts Institute of Technology

Lisbeth Gronlund holds a PhD in theoretical physics from Cornell University. She has worked on technical and policy issues related to nuclear weapons, missile defenses, and space weapons for over three decades. From 1992 to 2020 she worked at the Union of Concerned Scientists' Global Security Program, first as a Senior Scientist and, beginning in 2002, as Co-director of the program. Prior to joining UCS, she was a research fellow at the MIT Defense and Arms Control Studies Program and at the Center for International Security Studies at the University of Maryland. Lisbeth is a member of MIT's Laboratory for Nuclear Security and Policy.

Herbert Lin
Stanford University

Herbert Lin is senior research scholar and Hank J. Holland Fellow at Stanford University and works at the intersection of national security and emerging technologies. He is Chief Scientist Emeritus for the Computer Science and Telecommunications Board of the National Academies of Sciences, Engineering, and Medicine. and was a member of President Obama's Commission on Enhancing National Cybersecurity (2016). He served as a professional staff member and staff scientist for the US Congress House Armed Services Committee, where his portfolio included defense policy and arms control issues. Lin received his doctorate in physics from MIT.

Ryan Manzuk
Princeton University

Ryan Manzuk received his PhD in Geosciences at Princeton University in October 2024. His thesis used image analysis and computational methods to investigate the physical properties of ancient environments preserved in rocks, mostly fossil reefs, to investigate feedbacks between the physical environment, climate, and biological evolution. He also works with Situ Studio, Brooklyn, NY, as part of a team combining visual investigations, science, law, and advocacy on issues of human rights, environmental justice, policing, and civil liberties. As a Peace Corps volunteer he spent two years in Guinea working with a small village on sustainable food production practices.

Geralyn McDermott (she/her)
Princeton University

Geralyn McDermott joined the Program on Science and Global Security as Administrative Assistant in 2012. She provides administrative and research support to the Program's faculty, staff, and graduate students. In addition, Geralyn coordinates logistics for domestic and international conferences, arranges travel, and is responsible for expense reporting, and purchasing.

Zia Mian
Princeton University

Zia Mian is a physicist and co-director of Princeton University's Program on Science and Global Security. His research interests include issues of nuclear arms control, nonproliferation, and disarmament and international peace and security. He is a co-founder of the Physicists Coalition for Nuclear Threat Reduction. Mian serves on the Board of the Union of Concerned Scientists. In 2022, he was appointed to the UN Secretary-General's Advisory Board on Disarmament Matters. He is the co-chair of the Scientific Advisory Group of the Treaty on the Prohibition of Nuclear Weapons.

Igor Moric
Princeton University

Igor Moric is a Postdoctoral Research Associate in the Program on Science and Global Security. Previously, he worked as a postdoctoral researcher on the MIMAC and PandaX dark matter detectors at Tsinghua University in Beijing and SJTU in Shanghai, respectively. During his PhD at CNES and Paris Sorbonne he worked on the space atomic clock PHARAO. He has an advanced Master's degree in "Space Systems Engineering" from ISAE-SUPAERO in Toulouse.

Ali Nouri
Princeton University

Ali Nouri was a Deputy Assistant to President Biden and Deputy Director of the White House Office of Legislative Affairs. Previously he was an Assistant Secretary in the Department of Energy where he led the Office of Congressional and Intergovernmental Affairs. Before starting his career in Washington, DC, Nouri was a postdoctoral researcher with SGS in 2007–2008. He earned a B.A. in biology from Reed College and a PhD in molecular biology from Princeton University. Ali Nouri is now a lecturer at SPIA.

Charles Owink
United Nations Office for Disarmament Affairs

Charles Ovink is Political Affairs Officer at the United Nations Office for Disarmament Affairs (UNODA), in New York. His current focus is on responsible innovation, the impact of emerging technologies on disarmament and nonproliferation, military uses of AI, and disarmament education and outreach. Since 2023 he has been a leader of a UNODA initiative to test and develop educational materials that can be introduced into STEM education and help future AI practitioners address the risks for international peace and security at their source. He is a member of the IEEE-Standards Association Research Group on Issues of Autonomy and AI for Defense Systems. He received a master's degree in international relations from Waseda University, Japan, and an undergraduate degree in politics for Warwick University, England.

Patrick Park
Princeton University

Patrick Park is a third-year PhD student in Mechanical Engineering assessing dual-use aspects of various nuclear fusion reactor designs. Before Princeton, he was a licensed Senior Reactor Operator of a research reactor and worked with the Reactor Engineering Group at the NIST Center for Neutron Research. He studied Physics at Reed College, as well as Applied Physics and History at Columbia University.

Stewart Prager
Princeton University

Stewart Prager is a professor of astrophysical sciences at Princeton University, and an affiliated faculty member with the Program on Science and Global Security. From 2009–2016, he was director of the Princeton Plasma Physics Laboratory. He was vice-chair of the APS Forum on Physics and Society and is a co-founder of the Physicist Coalition for Nuclear Threat Reduction. He holds a PhD in plasma physics from Columbia University.

Shua Sanchez
Princeton University

Shua Sanchez is a materials physicist, research collaborator with the Program on Science and Global Security, and a 2025 Next-Generation Fellow with the Physicist Coalition for Nuclear Threat Reduction. His research involves a critical review of the scientific literature on plutonium aging effects used to justify U.S. plans for the production of new plutonium cores (pits) for existing and new nuclear weapons. From 2021 to 2025 he was a National Science Foundation Postdoctoral Fellow at MIT working on experimental condensed matter physics. He holds a physics PhD from the University of Washington (2021) and a B.S. in physics from the University of Wisconsin. As a longtime activist and union organizer, Shua was an elected member of the executive board of the University of Washington's graduate student union, UAW 4121, and has worked on Democratic political campaigns across the country.

Frank von Hippel
Princeton University

Frank von Hippel is a senior research physicist and professor of public and international affairs emeritus with the Program on Science & Global Security, which he co-founded in 1974. He received a D.Phil. in theoretical physics in 1962 from the University of Oxford. In 1993–1994, he was assistant director for national security in the White House Office of Science and Technology Policy. Von Hippel's many awards include a MacArthur Prize Fellowship.

Raven Witherspoon (she/her)
Princeton University

Raven Witherspoon is a PhD student in Princeton's Science, Technology, and Environmental Policy (STEP) program and a member of the Program on Science and Global Security. Raven was a Schwarzman Scholar at Tsinghua University, Beijing, receiving a master's degree in global affairs in 2022, and studying Mandarin Chinese as a Blakemore-Freeman Fellow. She holds an undergraduate degree in physics with minors in mathematics, political science, and international social justice studies from Virginia Commonwealth University, where she was a research assistant in the Department of Mechanical and Nuclear Engineering.

David Wright
Massachusetts Institute of Technology

David Wright received his PhD in theoretical condensed matter physics from Cornell University in 1983 and worked as a research physicist until 1988. Since then, he has worked on arms control and international security issues, researching technical aspects of nuclear weapons policy, missile defense systems, hypersonic weapons, and space weapons. From 1992 to 2020 he was a researcher with the Global Security Program at the Union of Concerned Scientists, serving as co-director of the program from 2002 to 2020. He also held research positions at MIT's Security Studies Program, Harvard's Kennedy School, and the Federation of American Scientists. David is a member of MIT's Laboratory for Nuclear Security and Policy.