AGA 4: Fissile Material and Proliferation Resistance

Zeit: Donnerstag 14:00–19:00 Raum: VMP 9 HS

Hauptvortrag AGA 4.1 Do 14:00 VMP 9 HS
Expanding global nuclear energy supply without increasing the risks of nuclear proliferation — •Steve Fetter — School of Public Policy, University of Maryland, College Park, USA

To avoid potentially catastrophic changes in the Earth's climate, world energy supply must shift over the next several decades toward carbon-free sources. Nuclear energy has particular promise for rapid and large-scale expansion worldwide, if a corresponding expansion in the risks of nuclear proliferation could be avoided. In recent years, attention has focused on limiting the spread of enrichment and reprocessing through a combination of export controls, voluntary agreements and incentives, and multinational ownership or international control. Iran and North Korea have demonstrated the limitations of export controls, due both to the diffusion of knowledge and technology and the willingness of individuals to engage in illegal trade for profit. Incentives has focused on the guaranteed supply of fresh fuel, but the the guaranteed take-back of spent fuel would be a far more powerful incentive for forego enrichment and reprocessing. Multinational ownership and international control are more promising long-term solutions, if they can be made binding on all states. A promising technological approach is the development of small, sealed-core reactors with long life-time cores. Such reactors would eliminate the need for any fresh fuel manufacture or spent-fuel handling by recipient states. Because small reactors could be economically competitive only if they were mass produced by a few suppliers, they hold the potential of centralizing enrichment and reprocessing in a few states.

AGA 4.2 Do 15:00 VMP 9 HS
Neutronics Calculations to Assess and Strengthen the Proliferation Resistance of Nuclear Technologies — •Matthias Englert and Wolfgang Liebert — IANUS, TU-Darmstadt, Hochschulstr. 4a, 64289 Darmstadt

Ambivalent nuclear technologies use or have a potential to produce nuclear weapon relevant material like highly enriched uranium, U233, plutonium and tritium. Three different cases for such technologies representing current, cutting edge and future technologies are assessed with regard to their proliferation potential and a focus on measures to strengthen their proliferations resistence. The assessment is carried out with the help of neutronics simulations. First we present results for the conversion of high flux research reactors to the use of low enriched uranium with the new simulation package developed in our group. Secondly the potential of spallation neutron sources to produce U233, plutonium and tritium is assed. Thirdly we briefly discuss the proliferation potential of the future use of fusion power plants. Finally the analysis of the three technologies is compared to explicate on this exemplary basis general criteria for the proliferation resistant use of nuclear technologies.

AGA 4.3 Do 15:30 VMP 9 HS
Radiative aspects in coupled nuclear fission-fusion processes — •Jens Fiedler and Peter Hafner — Fraunhofer Institut Naturwissenschaftlich-Technische Trendanalysen, Euskirchen, Germany

Boosting of fission processes using fusion neutrons is a well-known technique in developing compact nuclear fission devices. The Fraunhofer Institute for Technological Trend Analysis (INT) operates a coupled hydrodynamic-neutron transport program system, which also incorporates radiative processes. This program system allows studying the physics of interactions between fission and fusion processes. At high temperatures a significant amount of energy is governed by radiation. Radiation and the encapsulated material generally affect each other. The description of such a model requires the solution of the radiation transport equation, which is a complex task. Calculations performed in this work take radiation processes into account by a radiation heat conduction formulation. Besides presenting the basic concept of fission-fusion devices, first results from coupled fission-fusion calculations are given in this presentation.

30 min break

Hauptvortrag AGA 4.4 Do 16:30 VMP 9 HS
On the Challenges of Containing the Spread of Gas Centrifuge Enrichment Plants — •Houston Wood — Mechanical & Aerospace Engineering University of Virginia Charlottesville, Virginia 22904

Since the end of the Cold War, a number of non-nuclear weapon states have pursued enrichment of uranium by gas centrifuges. At the moment, the most challenging case is that of Iran, who has continued to build their gas centrifuge plant. Iran contends they only want to make enriched fuel for nuclear reactors, but the line between civil and military enrichment activities is very thin. The IAEA and Western countries are trying to find ways to assure that Iran does not produce uranium enriched to weapons grade levels. In this talk, I will describe gas centrifuges and cascades of gas centrifuges, and I will discuss the challenges of safeguarding enrichment plants. I will also discuss possibilities for thickening the thin line. These efforts are of utmost importance, not only for Iran, but for other nations that may want to pursue the nuclear fuel cycle in the future.

AGA 4.5 Do 17:30 VMP 9 HS
Proliferation risks of highly enriched uranium used for medical isotope production — •Martin B. Kalinowski — ZNF, Universität Hamburg

The use of highly enriched uranium (HEU) for medical isotope production is of concern for proliferation. The used target material is still of proliferation concern since only about 2% of the HEU is consumed, the irradiation time is in the range of two to ten days and part of the radioactivity is removed by chemical separation. As a result, after some cooling time the radiation barrier is not very high. While the global demand of HEU for research reactors is declining from more than 1,500 kg per year in 1978 to projected 500 kg/y in a few years, the use of HEU for medical isotope production is increasing and likely hitting an annual consumption level of 100 kg soon. Since molybdenum-99 is the most widely used medical isotope, the amount of irradiated HEU can be estimated from its consumption rate.

AGA 4.6 Do 18:00 VMP 9 HS
Abschätzung des Proliferationspotentials eines Fusionsreaktors: mögliche Pu-239 Produktion und Bestimmung des Isotopenvektors — •Fabio Balloni — TU Darmstadt Deutschland

Tokamak-Fusionsreaktoren, die auf einem Deuterium-Tritium Brennstoffzyklus basieren, müssen so konzeptioniert sein, daß die erforderlichen Tritiummengen im Reaktorsystem selbst produziert werden können. Dazu wird als Edukt Lithium-6 in die modular aufgebauten Reaktorwände eingespeist, um so über Neutroneneinfänge das benötigte Tritium zu erhalten. Das Design dieser Module, die sog. Blankets, erlaubt es, auch andere Brutstoffe im Reaktor zu platzieren, bspw. Uran. Dies würde die Produktion von Plutonium-239 ermöglichen. Um das Proliferationspotential einer solchen Konfigurierung abzuschätzen, wurde die Fusionsneutronik mit dem Monte Carlo Code MCnPx simuliert. Dazu wurde ein maßstabsgetreues, 3D Modell einer kommerziellen Fusionsreaktorkonzeption PPCS-A, veröffentlich 2006 durch die European Fusion Development Agency (EFDA), erstellt. Darüberhinaus wurde durch die Abbrandroutine MCMATH die Isotopenverteilung des produzierten Plutoniums berechnet. Im Vortrag werden Ergebnisse dieser Simulationen vorgestellt und diskutiert. Außerdem wird auch auf eine mögliche Verwendung des Fusionsreaktors in einem Fusion-Fissions-Hybrid Satellitensystem eingegangen.

AGA 4.7 Do 18:30 VMP 9 HS
Proliferation Risk of Plutonium Fuels: Burnup Calculations, with Particular Regard to Pu238 Fractions — •Moritz Kütt[1], Matthias Englert[1], Wolfgang Liebert[1], and Christoph Pistner[2] — [1]IANUS, TU-Darmstadt, Hochschulstr. 4a, 64289 Darmstadt — [2]Öko-Insitut e.V., Rheinstraße 95, 64295 Darmstadt

One solution, besides elimination or immobilization, to address the proliferation risk associated with existing plutonium stockpiles can be the use as fuel for energy production in light water reactors. To make plutonium fuel more proliferation resistant it is favorable to have a high percentage of Pu238 in the spent fuel which increases the heat development and the neutron rate of the plutonium significantly and makes it less usable for the construction of nuclear weapons. Different fuels were proposed to reach this goal and increase the Pu238 build up. Among them pure uranium or MOX fuels with a small percentage of

U236 or plutonium in Inert Matrix Fuels (IMF) with or without additional minor actinides. To investigate the Pu238 buildup capability of these fuels, burnup calculations were performed with an improved version of the coupled neutronic and burnup code MCMATH. We present and compare the results for these fuel types with regard to the amount of Pu238 produced and proliferation relevant factors like the heat and neutron rate and the critical mass of plutonium generated after burnup. The comparison shows that IMF fuels are favorable with regard to their proliferation resistance compared to MOX/pure uranium fuels.