Nuclear Forensics

Vorsprung durch Technik

Nuclear forensic expert Klaus Mayer talks about the new tools of atomic investigations.

by Giovanni Verlini

Question: In the past, nuclear inspectors were considered to be "nuclear accountants", while as of late they are portrayed as investigators. It is often said that this shift in public perception is due to the development of nuclear forensics. How has nuclear forensics evolved over the past years?

Klaus Mayer: We have frequent contact with the IAEA, with the Department of Safeguards, with the Safeguards Analytical Laboratory and with the Office for Nuclear Security. In the discussions and in the technical cooperation we also experience this shift in activities of the IAEA and of its inspectors in particular.

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The driving force behind this evolution is certainly the move from traditional safeguards (INFCIRC 153) to the Additional Protocol (INFCIRC 540) and to Integrated Safeguards. A combination of different technical measures provides the tool-set for the implementation of these agreements. Nuclear forensic science provides clues on the history and possibly on the origin of nuclear material.

Today, we have a systematic and comprehensive approach for analyzing seized nuclear material. Parameters like isotopic composition, chemical impurities, particle morphology or the age of the material provide useful hints on the material under investigation.

Our laboratory, the JRC — Institute for Transuranium Elements, experienced an increasing number of requests for impurity measurements in certain types of nuclear material. This is a clear indication of the trend towards more investigative safeguards.

Q: What are the typical nuclear forensic tools available today?

KM: The measurement techniques applied in nuclear forensics comprise of methods that have been traditionally used in nuclear safeguards, in isotope geology or in material sciences. Investigative radiochemistry, however, remains the backbone of any nuclear forensic analysis.

The actual measurements, though, provide only data which are partly self-explaining. For interpretation of the data we often need to rely on reference information, which is obtained through model calculations, through data bases or through the open literature. All these parameters are combined to a "nuclear fingerprint." In any case, a good understanding of the nuclear fuel cycle and of nuclear physics and radiochemistry is key for interpretation and attribution.

Q: Looking forward, what kind of nuclear forensic tools are being developed today for the future?

KM: Today, we are working in several areas. On the one hand, we investigate new, characteristic parameters, like the isotopic composition of trace elements. On the other hand, we are also working on the application of classical forensic techniques (like taking fingerprints or DNA) on radioactively contaminated evidence. Furthermore, the application of micro-analytical techniques enables us to investigate individual particles of only few micrometers in size. Nuclear forensics is very powerful and significant development work is performed to further increase its effectiveness. Beyond the technical developments, increasing emphasis is put on the implementation of a comprehensive concept, covering the investigations from the crime scene to the laboratory.

This "model action plan" was conceived by the Nuclear Smuggling International Technical Working Group (ITWG) and is being propagated also by the IAEA.

Q: Are remote detection technologies being developed for those cases where there is no physical access to a facility?

KM: Remote detection technologies are being developed. Today most of the available techniques provide an indication on the activities being performed inside a facility where the inspector has no access.

With progressing development of such methodologies the nuclear forensics value will certainly increase.

Q: How important is nuclear forensics in the fight against nuclear trafficking, terrorism and proliferation?

KM: The three main steps in combating illicit trafficking, nuclear terrorism and proliferation are prevention, detection and response. Prevention is certainly the most effective and efficient way of keeping nuclear material under control. Regaining control over material that has been diverted or stolen requires significantly higher efforts. Nuclear forensics provides clues on the history and on the origin of nuclear material.

It is therefore an important element of sustainability in combating illicit trafficking or proliferation. Because if the place of theft or diversion can be identified, appropriate countermeasures can be taken to avoid that such incidents are repeated in the future. Moreover, if the source of the material can be traced back, also the perpetrators handling the material take a high risk of being identified. Nuclear forensics therefore provides a strong element of deterrence.

Q: What is the relationship between the JRC-ITU, the IAEA and other national and international bodies involved in nuclear forensics?

KM: JRC-ITU is a research institute of the European Commission. Nuclear forensics is one of our activities and we draw upon the rich experience in nuclear material analysis in our laboratory. This experience is made available to the IAEA through the European Commission's support programme to the IAEA, through participation in co-ordinated research activities and through consultant's meetings and joint activities.

In the specific area of nuclear forensics, the ITWG takes a prominent position, as this group gathers the key players in the area and is in continuous dialogue with the IAEA. Exchanging experience and international cooperation are very important for advancing nuclear forensic science and thus for sustainable success in combating illicit nuclear trafficking, terrorism and proliferation.

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Europe's Nuclear Science Lab

The mission of the Institute for Transuranium Elements (ITU) is to provide the scientific foundation for the protection of the European citizen against risks associated with the handling and storage of highly radioactive material. ITU's prime objectives are to serve as a reference centre for basic actinide research, to contribute to an effective safety and safeguards system for the nuclear fuel cycle, and to study technological and medical applications of radionuclides/actinides.

ITU works very closely with national and international bodies in the nuclear field, both within the EU and beyond, as well as with the nuclear industry. In addition to playing a key role in EU policy on nuclear waste management and the safety of nuclear installations, ITU is also heavily involved in efforts to combat illicit trafficking of nuclear materials, and in developing and operating advanced detection tools to uncover clandestine nuclear activities. ITU provides the expertise and access to the necessary special handling facilities for the study of the actinide elements. This is of relevance for issues related to nuclear power generation and radioactive waste treatment and disposal, but also for the advancement of science in general. Another key role is in the study and production of radionuclides used in the treatment of cancer.