Feasibility of Using a Multi-Reflection Time-of-Flight (MR-TOF) Mass Spectrometer for Nuclear Safety and Security

Ankur Chaudhuri, Bryan van der Ende, Ghaouti Bentoumi, Bhaskar Sur

Canadian Nuclear Laboratories, Chalk River, ON, Canada

Mass spectrometry is an important tool for nuclear safety and security as it can identify and quantify the elemental and isotopic signatures of nuclear material within a sample. Current techniques such as Inductively Coupled Plasma Mass Spectrometer (ICP-MS) or Thermal Ionization Mass Spectrometer (TIMS) are sufficient for fingerprinting radioisotopes to meet the demands of nuclear safety and security, but do so only in a fixed laboratory environment, at a significant cost. In comparison, the Multi-Reflection Time-of-Flight (MR-TOF) mass spectrometer technology may offer a field deployable technique with a unique combination of portability, robustness, mass resolution and cost, capable of achieving similar results to the traditional methods. This could potentially enhance the investigation of radiological or nuclear security events by characterizing the radioactive material at its source. The game changing potential of MR-TOF mass spectrometer is to greatly enhance the accessibility and capacity to analyze nuclear materials, both due to reduced costs, while also providing mobility for on-site investigations in real-time. Although the significantly reduced footprint and the mass resolution of MR-TOF instrument is very promising, a substantial challenge to adopt this technology for practical use arises from the space-charge effect of trapped ions. Another obstacle in using MR-TOF for in-situ mass spectrometry is the requirement for sample preparation and sample ionization in the field. This presentation examines the opportunities and challenges for adopting the MR-TOF technology for applications in the sphere of nuclear safety and security, such as nuclear forensics, emergency dosimetry, safeguards, and reactor accident investigations.