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Innovation in neutron and gamma sensor technology and AI-enhanced analysis for security applications

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Global geo-political and economic instabilities and uncertainties mean that our security services are under increasing pressure to respond to suspected and genuine incidents under time pressures and with limited resources. These conditions impose challenges on the equipment used and the underpinning technologies, in order to ensure ease of use, robustness under increasingly under environmental conditions, detection sensitivity and technical reliability with respect to false alarms, detection reliability and cost-effectiveness.
Mirion serves many customers in the security and nuclear material safeguards services, supplying products in many countries, and in support of many facets of the industries. This includes working extensively with users, regulators, and laboratories engaged in the accreditation of the technology and products. It also requires careful maintenance of the underlying technology portfolio.
Key technologies underpinning security applications are usually based on remote detection of characteristic radiation signatures. This ensures ease of access for operators while minimising direct exposure to potentially hazardous items. Normally, this means that gamma spectroscopy or gross gamma counting (dose rate), or neutron measurements (either dose rate or neutron counting in Totals or Coincidence modes) are suitable for use with inspection probes. In order to deal with varied requirements for deployment, delivery of these detectors through either Unattended Automated Vehicles (UAVs), backpacks, crawlers, or quadruped robots or similar, are often considered.
In Mirion, our teams work extensively with customers to conduct field trials, ensuring user interfaces, ergonomics, detector responsiveness and serviceability, are all matched to user requirements. As part of our technology program, we work with many national laboratories and universities to ensure that maximum advantage is taken of existing technology, thus minimising development time and costs to convert into field products, whilst actively supporting and developing skills development through the universities through for example PhD programs. In this paper we present examples of such work with reference to previous case studies. Examples include exploration into emerging detector technologies such as perovskites, diamond detectors and Si carbides, and aligning technological features and performance characteristics, for example relative neutron and gamma sensitivity, to the application - driven field conditions, for example with respect to temperature and radiation hardness of components. Our work also includes constant appraisal of neutron detection technology and we give examples of lessons learned from field-proven installations involving neutron detectors operating in harsh environmental conditions for example waste management, and where this experience can carry over to in-field applications such as safeguards, security and emergency response inspections.
We give an industry perspective on the issues surrounding data management, from experience serving many fields. We describe how software integration tools can streamline data collection and make it more universally accessible to different customer teams. Increasingly, Artificial Intelligence techniques are becoming studied more widely. Again we give an industry perspective with reference to our developments aimed at accelerating and automating spectral analysis in ways that allow complex patterns of characteristic features to be recognised, whilst addressing issues of user confidence and validation.

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