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Active Detection of SNM: Ten years of collaborative active interrogation work by the Atomic Weapons Establishment

Between 1993 and 2018 almost 3500 incidents of radiological/nuclear material being handled outside of regulatory control occurred, some 1250 were possibly related to trafficking and malicious use with 27 incidents involving Special Nuclear Material (SNM). Finding material outside of regulatory control presents many well understood challenges, not least of which is the potential for weak radiation signatures due to the standard constraints of time, distance and shielding. At issue is the potential to fail in the detection of such material which can, at face value, only be alleviated through the disruption of commerce by slowing cargo (increasing detection time), placing detectors right up against cargo (reducing distance) or opening cargo (bypassing shielding). An alternative approach is to increase the radiation signal by inducing fissions using an external source of radiation, thus allowing the resultant fission radiation signature to be detected through any shielding present on detectors placed outside the cargo, all within a timeframe which does not unduly interfere with the stream of commerce. This technique is termed Active Detection.

Since the turn of the century, Active Detection of shielded special nuclear material (SNM) for nuclear security applications has been the focus of a great deal of work by agencies worldwide. Inducing fissions in order to assay material is not a new concept and has been used since the 1960s for nuclear materials accountancy, processing/quality control etc. Such Active Non-Destructive Assay techniques tend to look to determine material mass/isotopics in geometries that allow small standoff in well characterised environments over long periods of time, the challenge is making this technique work in a border security scenario.

The Atomic Weapons Establishment (AWE) alongside the UK Government have maintained a programme to develop Active Detection techniques and technologies since 2008 and much work has been done, both by AWE and in collaboration with international partners during this decade. Significant progress has been achieved across a range of radiation sources, radiation detectors, data acquisition systems, and data analysis tools. This body of work leads us invariably to the conclusion that Active Detection works, that currently available technologies, when correctly configured and integrated, can successfully detect shielded SNM in a wide variety of realistic configurations. We describe ten years of experimental campaigns: from bench-top trials to multimillion-pound demonstrator systems, to show how the resulting data validates active interrogation as a technique, and discuss the remaining challenges.

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