False Alarm Reduction in Portal Monitors utilizing the FastTrack Technology

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Many colleagues at Mirion Technologies have been involved in the development of the FastTrack Technology and its implementation in various products. Their contribution is greatly appreciated.

Introduction

Portal monitors to scan vehicles and pedestrians for ionizing gamma radiation are widely used, e.g. in the nuclear industry, in homeland/event security applications or in radiological emergency scenarios. Unfortunately a lot of false alarms are occurring due to the fact that commonplace portal monitors are not able to distinguish between sources being carried through the monitor and sources that are located nearby but outside the pillars of portal monitors. Due to the nature of a single detector any ionizing radiation - irrespective of the location from which it irradiates - generates a measurement effect. Significant false alarm rates are the consequence leading to a lack of confidence in the used technology, especially in situations where a lot of persons want to leave the area but need to wait for clarification of the alarm results.

In the following, a novel method - Mirion Technologies' patented FastTrack Technology - is presented which, amongst other positive features, is able to clearly distinguish between sources being carried through the portal monitor´s pillars and those sources or contaminations being located nearby but outside the monitor. The FastTrack Technology is therefore particularly useful in challenging background conditions, e.g. at Chernobyl or Fukushima but also for applications in which high frequency measurements are expected. This may involve outages of NPPs, radiological terror prevention at airports/customs or large scale events/venues. After having explained the basics of FastTrack Technology, examples of real life applications are presented.

Basics of FastTrack-Technology

The basic idea of the FastTrack-Technology is both very simple and very effective: In contrast to commonplace portal monitors which are composed of a single detector per pillar, the FastTrack-Technology is based on three (or more) horizontally arranged detectors per pillar as illustrated in figure 1.

Depending on the direction in which a source is moving through the monitor, the detector electronics respond in a different way: given a source approaches from the left, the "black" detector responds first whereas the "green" detector responds last. Furthermore, the sequence of the signals peak amplitudes in this example is black → red → green. A source approaching from the right would reverse the sequence into green → red → black. Any movement in between these two initial positions would cause a smooth transition in-between the signal sequences and amplitudes.

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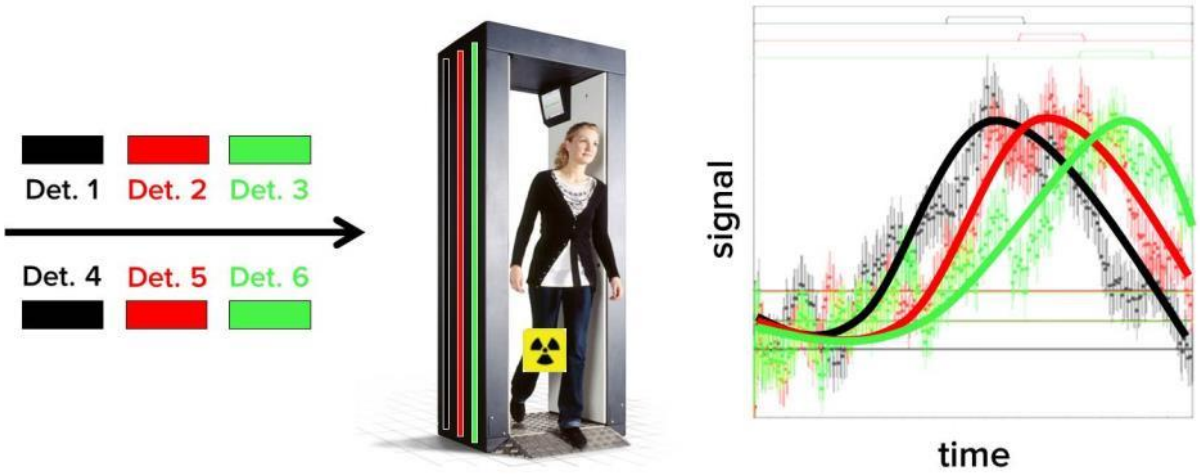

Figure 1: Detector arrangement in FastTrack-Technology; example: Mirion Technologies' FastTrack-Fibre™.

As shown in this simplified example, the direction of movement of the source can be determined based on the temporal profile of the measurement signals from all three detector arrays. Mirion Technologies' FastTrack Technology compares this information to the direction and speed of movement of the object or person currently being measured (which is independently determined by multiple light barriers). This allows a reliable distinction of sources being carried inside/through the monitor from sources and dynamic background fluctuations originating from outside the monitor.

Limitations to this approach are mainly given by electronics noise, geometrical imperfections, and complex source geometries. Thus, a down to the "degree" resolution of the source's direction of movement is not possible today.

Successful measurement operation of the FastTrack Technology is not limited to sources or contamination being moved but can also handle staircase signal shapes which e.g. occur when doors to a close-by radiologically controlled area are opened. In this case all detectors would respond with an identically temporal staircase signal profile which can be clearly distinguished from the specific profile of a source/contamination being carried through the monitor (sinusoidal shape).

In this way the main reason of false alarms in portal monitors is eliminated both for moving sources as well as static ones.

Furthermore, the FastTrack Technology ensures, thanks to its advanced algorithms, measurements without waiting times (walk-through mode) of pedestrians or vehicles without compromising MDA-levels.

Examples

Figures 2-4 are showing typical measuring situations in which commonplace portal monitors would respond with false alarms whereas FastTrack Technology ensures trouble free operation:

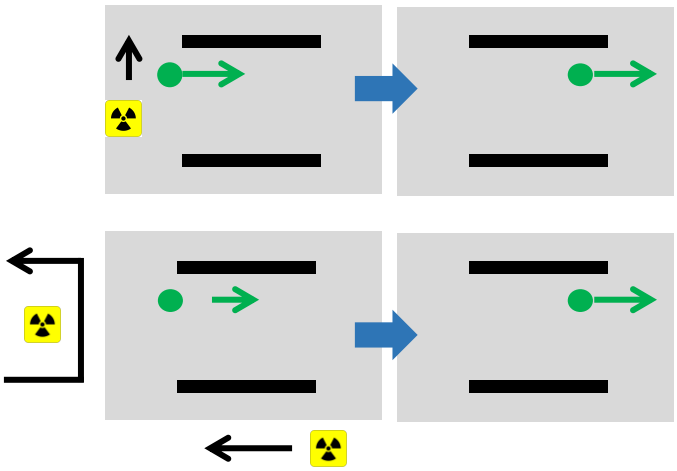

Figure 2: Moving sources during successful operation of Mirion Technologies' FastTrack-Fibre™

While sources are present in the vicinity of a FastTrack monitor during measurement operation the signals of all detectors are significantly different from each other, both in chronological order as well as in amplitudes. As explained above, the FastTrack algorithms can reliably distinguish the fraction of the signal originating "inside" the monitor from the contributions from outside sources. For the sake of precaution, the FastTrack monitors can be configured to highlight measurements where external effects are detected by descriptive indications such as "external contamination" or "non-dynamic" in order to provide additional information to the radiation protection engineer.

In addition, the FastTrack Technology prevents an (un-)intentional extraction of sources from controlled areas, as depicted in figures 3 and 4: when a source is carried into the monitor and remains inside, the rising edge of the detectors signals will not proceed to a trailing edge when the person leaves the monitor without the source. A corresponding alarm is given by FastTrack monitor.

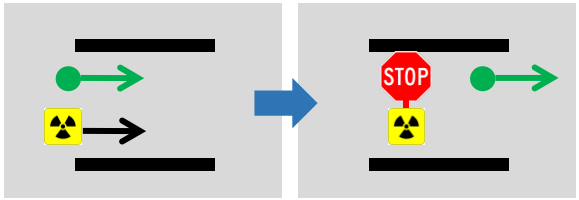

Figure 3: Source remaining inside the monitor

The same is done when a stationary source inside the monitor is extracted from the monitor. In this case, a trailing edge of the detectors signals is detected without rising edge in the beginning of the measurement. The FastTrack monitor will give a corresponding alarm.

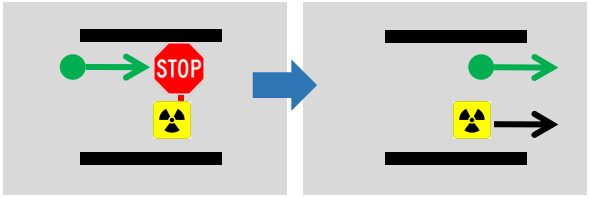

Figure 4: Source taken away from inside the monitor

Notwithstanding the examples above, all "true" contaminations are detected by the FastTrack Technology – irrespective of sources inside or outside the monitor.

FastTrack-Vehicle™ monitor in Fukushima

Mirion Technologies' patented FastTrack Technology has been invited for a test of vehicle monitors nearby Fukushima, Japan for demonstrating its efficiency. Measurements of all vehicles leaving the 30km area around Fukushima have been performed with an MDA of 4 Bq/cm^2 Cs-134 at walking speed. Mirion Technologies' FastTrack-Vehicle™ monitor has been chosen for this test. The two pillars where placed at a distance of 6m clear width, as illustrated in figure 5.

Figure 5: FastTrack-Vehicle™ in operation nearby Fukushima

For the project team it was of particular interest how the FastTrack Technology would perform in high backgrounds of about 1–2 µSv/h due to contaminated soil. All measurements had been carried out over a period of three weeks. In the very beginning, additional steel plates had been mounted above the soil to artificially decrease the background, see figures 6 and 7. However, this countermeasure proved to be unnecessary as the FastTrack-Vehicle™ could fulfill all requirements without these additional means.

Figure 6 and 7: FastTrack-Vehicle™ in operation nearby Fukushima

FastTrack-Fibre™ pedestrian monitor at major sporting event

As a counter terror measure during a major sporting event it was of highest importance to scan all (100 %) of the approx. 4.1 million spectators, attendees, politicians, security personnel, etc. for radiological threats when entering the arenas. Due to the expected large number of accesses at each access point the organizers expected an uninterrupted passage of pedestrians into the arenas, i.e. no tailbacks were allowed, but people should be able to move more or less "as they like". As a solution to these challenging requirements each access point was equipped with a dedicated FastTrack-Fibre™ portal monitor, as shown in figure 8.

Figure 8: Mirion Technologies' FastTrack-Fibre™ pedestrian monitor

Entering the portal monitors was only possible through restricted guidance systems, as illustrated in figures 9 - 11.

Figure 9: Schematics of arrangement to guide visitors incl. radiation scan by FastTrack-Fibre™

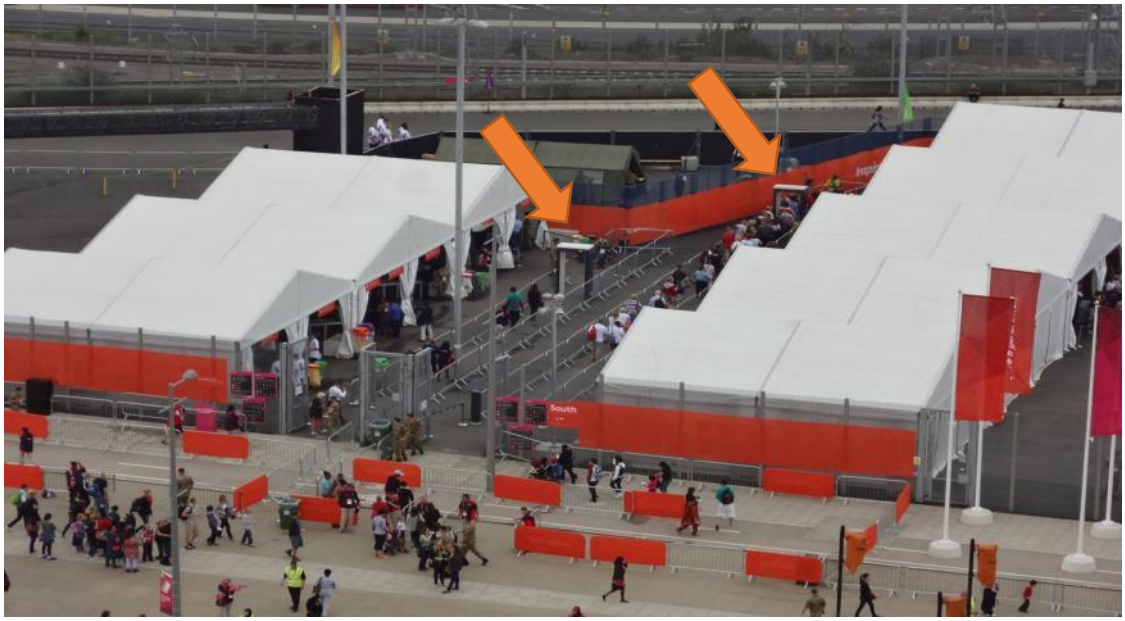

Figure 10: Live situation of visitors entering arenas incl. radiation scan by FastTrack-Fibre™

Figure 11: Live situation of visitors entering arenas incl. radiation scan by FastTrack-Fibre™

When a contamination has been detected, a group of 1 - 3 persons was isolated from the crowd and each person of the group was manually checked with handheld spectroscopic devices.

This measurement campaign for radiological threats has been the first of its kind and dimension, worldwide. Some impressive figures have been reported:

- 4.1 million measurements have been executed by 19 FastTrack-Fibre™ monitors over a period of 19 days.
- This corresponds to over 10.000 measurements per day and monitor.
- The most intensively used monitor carried out over 300.000 measurements within 19 days.
- Throughout the whole period 72 alarms have been detected. All resulting from medical treatments of the corresponding persons.
- No false alarm events were generated in the 4.1 million measurements.
- Due to these impressive figures the CBRN "Counter Terror Award" has been awarded to the FastTrack-Fibre™ monitors.

Conclusion

The FastTrack Technology has been invented to reduce false alarms in portal monitoring for ionizing gamma radiation. It is based on a sequential three-detector-arrangement, which allows correlating the measurement signals to the movement of the measurement object (or person). Consequently, it can be clearly distinguished if a source of ionizing radiation is moving with the measurement object through the monitor or if it is located outside the monitor. This leads to a significant false alarm reduction w.r.t conventional portal monitors, especially in challenging background conditions.

Two applications have been presented:

- Mirion Technologies' FastTrack-Vehicle™ monitor has been operated near Fukushima. The test demonstrated a robust performance also in significantly elevated gamma background of 1–2 µSv/h.
- Mirion Technologies' FastTrack-Fibre™ pedestrian monitor has been used for a large-scale radiological screening at a major sports event. Throughout the event 4.1 million measurements have been performed by 19 monitors. Not a single false alarm occurred.

FastTrack Technology has been developed and patented by Mirion Technologies (RADOS) GmbH. For further information please visit www.mirion.com or contact Tel.: +49-(0)40-85193-0 or info-de@mirion.com.