B59 Ion Trap Mobility Spectrometry Nuisance Alarm Threshold Analysis for Illicit Narcotics Based on Environmental Background and a Receiver Operating Characteristic (ROC) -Curve Approach

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After attending this presentation, attendees will understand the effect environmental background has on the sensitivity and specificity of Ion Mobility Spectrometry (IMS) narcotics trace detection.

This presentation will impact the forensic science community by demonstrating the discriminative potential of an IMS for trace detection of illicit narcotics relative to the environmental background.

The rapid and sensitive detection of illicit narcotics remains vital to a multitude of law enforcement, corrections/prisons, customs and border protection, and transportation agencies. Laboratory-based analytical techniques including Thin-Layer Chromatography (TLC), Gas Chromatography and Liquid Chromatography (GC and LC), Capillary Electrophoresis (CE), and Mass Spectrometry (MS) have been developed and utilized for the detection of a wide range of narcotic compounds; however, many of these techniques require additional laboratory infrastructure and are not conducive to field deployment or point-of-measurement screening. Colorimetric methods for the detection of narcotics have been developed and provide rapid detection in the field; however, these presumptive tests are subject to screener interpretation of the resulting color(s) and require onsite reagent mixing. In recent years, IMS has surged forward as a robust field-deployable analytical technique for the trace detection of a wide range of compounds, most notably explosives, Chemical Warfare Agents (CWAs), and illicit narcotics.

The discriminative potential of an ion mobility spectrometer for trace detection of illicit narcotics relative to environmental background was investigated with a Receiver Operating Characteristic (ROC) curve framework. The IMS response of cocaine, heroin, methamphetamine, 3,4-Methylenedioxymethamphetamine (MDMA), and Δ^9-Tetrahydro-Cannabinol (THC) was evaluated against environmental background levels derived from the screening of incoming delivery vehicles at a federal facility. More than 20,000 samples were collected over a multiyear period under two distinct sets of instrument operating conditions, a baseline mode and an increased desorption/drift tube temperature and sampling time mode. ROC curves provided a quantifiable representation of the interplay between sensitivity (True Positive Rate (TPR)) and specificity (1 – False Positive Rate (FPR)). A TPR of 90% and minimized FPR were targeted as the detection limits of IMS for the selected narcotics. MDMA, THC, and cocaine demonstrated single nanogram sensitivity at 90% TPR and <10% FPR, with improvements to both MDMA and cocaine in the elevated temperature/increased sampling mode. Detection limits in the tens of nanograms with poor specificity (FPR ≈ 20%) were observed for methamphetamine and heroin under baseline conditions; however, elevating the temperature reduced the background in the methamphetamine window, drastically improving its response (90% TPR and 3.8% FPR at 1ng). On the contrary, the altered mode conditions increased the level of background for THC and heroin, partially offsetting observed enhancements to desorption. The presented framework demonstrated the significant effect environmental background distributions have on sensitivity and specificity. The implementation of ROC curves demonstrated the significant effect environmental background has on the sensitivity and specificity of IMS trace detection. The particular distribution of environmental background for each screening arena must be considered when evaluating the detection and discriminative potential of a methodology.

IMS, ROC Curve, Narcotics