B162 A Portable X-Ray Fluorescence Instrument for Forensic Investigations

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After attending this presentation, attendees will understand the critical design features and operational parameters of a new, portable x-ray instrument for assisting in the recognition of trace evidence for crime scene and forensic laboratory applications.

This presentation will impact the forensic community and/or humanity by describing the development of a portable x-ray fluorescence instrument; demonstrating the operational performance of the instrument for trace residua of forensic importance, including (but not limited to) primer residue, blood, and semen in a simulated crime scene; and discussing the future use of this instrument at crime scenes or in the laboratory to develop investigative leads by assisting in the recognition and recovery of such trace evidence through elemental analysis.

A rugged x-ray fluorescence (XRF) instrument has been designed to investigate trace element content in and on evidence at crime scenes. The initial focus is to identify possible materials of interest such as gunshot residue and bodily fluids, but it has broad capability for general XRF applications. The instrument was designed to be part of a system to aid crime scene investigation and transmit the data to locations requiring it. This portable instrument was designed to meet the constraints of weight, battery operation, and ruggedness. Some special design features, however, were needed to achieve detection of microgram quantities of the trace elements of interest.

This instrument is part of a Teleforensics program jointly funded by NIJ and NASA. This collaboration seeks to develop cost-effective instrumentation based on technology developed for the space program to benefit crime scene investigation, and to develop advanced instrumentation for planetary missions for NASA. A critical factor at crime scenes is the collection of evidence for analysis at forensic laboratories. The friable nature of evidence requires rapid recognition, to avoid losing the probative information contained therein. Some evidence is invisible to normal investigation techniques, either because it involves trace quantities not visible to any investigation technique, or because it is covered or hidden from view. Many types of potential evidence can be indicated by crime scene detection through *in situ* trace element analysis.

Data is shown that supports possible use of a portable XRF instrument through detection of gunshot residue, blood (through the detection of the iron in hemoglobin), and semen (through the detection of zinc protoporphorin). To detect the low levels of trace element concentrations, advanced technology has been incorporated including the unique x-ray generator and a recently developed Shottky cadmium telluride x-ray detector. The design of the internal structure of the instrument is a critical component for minimizing the background due to coherent scattering. This design was necessary to ensure that the instrument could measure microgram quantities of elements of interest. It was also necessary to select the x-ray tube anode material to ensure that the tube's x-ray line production does not interfere with the detection of elements of forensic interest.

A key feature for the efficient and reliable operation of the instrument is spectral analysis software that can adapt to changing backgrounds and arbitrary elemental content. The results are incorporated in a database that was originally developed for planetary missions. In addition, it is now understood that the application of historically-derived XRF data loaded into a relational database representing data relationships between items of interest and background matrices is just as important in forensic applications as has been recognized for planetary missions. Discussion of the use of such relational databases to assist in data recognition and recovery, and those data related to forensic trace evidence either available or researched to date, will also be included.

The authors have also helped develop a Monte Carlo code for modeling the interaction of x-rays from any inputted source and the secondary particles that they produce as they interact with any type of material. This code can simulate the x-ray fluorescence produced by a variety of forensic materials (e.g., blood, semen, gunshot residue).

Finally, results of experiments to date characterize the expected performance of the instrument for detecting trace element concentrations that are useful for investigating crime scenes and in laboratory applications.

Teleforensics, Trace Recognition & Recovery, Portable X-Ray Fluorescence

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