A83 Field Forward Rapid DNA Analysis Outside the Laboratory: A Ruggedized System for Fully Automated Generation of STR Profiles

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After attending this presentation, attendees will learn of recent advances in rapid DNA analysis systems that enable forensic sample analysis to be performed rapidly in field-forward settings, mechanisms for long-term reagent storage at room temperature to support field-forward operation, and instrumentation features that enable transportation to and operation of rapid DNA analysis instruments in the field.

This presentation will impact the forensic science community by introducing a fully integrated, samples-in to answers-out short tandem repeat (STR) analysis system that offers the potential for use in a wide range of out-of-laboratory settings, including police stations, borders and ports, military checkpoints, and the battlefield.

Applications for the generation of STR profiles in the field include forensic investigations, determination of battlefield friend or foe, verification of kinship in immigration cases, and victim identification at mass casualty sites. To fully impact these applications, however, Rapid DNA Analysis systems must be ruggedized to allow transport and field-forward operation. Critically, all system reagents must be stable at room temperature for extended periods as many of the projected sites of operation are not amenable to refrigerated storage.

The system to be presented is immediately operational with full functionality after transport and capable of generating STR profiles from buccal samples in approximately 83 minutes without the need for a technical operator. To enable room temperature storage and stability, all reagents are stored within a single-use BioChipSet. Certain reagents, including the PCR reaction mix and Internal Lane Standard are lyophilized. The remainder, including electrophoresis and guanidinium-based purification reagents, are stored in liquid form in sealed aliquots within the BioChipSet. The liquid reagents are automatically released and the lyophilized reagents are automatically resuspended during sample processing. For example, the lyophilized PCR reaction mix is resuspended by an aliquot of the purified DNA solution generated during processing. Approaches to reagent storage and automated release will be discussed.

The Rapid DNA Analysis system was designed to be readily transported to and operated in the field. The instrument can be uncrated and set up in less than 15 minutes, is ready for use without any recalibration or adjustments, and can be operated with AC voltage between 90V to 260V (50 or 60 Hz) using utility or generator power. Several design features have been incorporated to provide ruggedization for field-forward operation including: (1) shock isolation and vibration dampening features in the mechanical chassis to protect the highly sensitive optical subsystem; (2) temperature control features to maintain electrophoresis run temperature to within one degree even with wide swings in ambient temperature; (3) lane-finding software to automatically align the optical detection system for each run; and, (4) partitioning of subsystems to protect against shock and vibration. The completed system was tested to MIL-STD 810F for transport. These tests included:

- Transit Shock – The instrument was crated, raised 12" above a solid concrete floor and dropped as prescribed in the test procedure.
- Bench Shock – The instrument was placed on a laboratory benchtop and raised on one side with by 4" and released, as prescribed in the test procedure.
- Vibration Testing – The crated instrument was placed on a vibration table and exposed to the vibrational frequencies for truck transportation as prescribed in the test procedure.

Data for the MIL-STD tests, automated subsystem tests, and functional tests will be presented to demonstrate that the system meets or exceeds all requirements for STR analysis in field-forward operation.

Rapid DNA, Ruggedization, MIL STD 810F

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