Abstract
The μChemLab™ program is developing hand-portable systems for detecting a broad range of chemical, biological, and viral agents in both gas and liquid samples. The μChem Lab liquid sample analyzer employs electrokinetic sample injection, chip-based electrophoretic microseparations and laser-induced florescence detection to analyze liquid samples. A second-generation liquid phase prototype is described. The device incorporates improvements from technological advances and applied research experience. New features include a modular design that readily accommodates on-chip preconcentration and additional separation techniques. The redesign reduces hardware failures, minimizes downtime during component replacement, improves usability, and provides increased sensitivity. Improvements have been made without compromising previous system performance.

Keywords: lab-on-a-chip, microanalytical system, electrophoresis, fluorescence detection, electrodes, power supply, optics, integrated

1. Introduction
The μChemLab™ liquid-phase microanalytical system prototype is being developed to detect a broad range of biological, and viral agents. A second-generation prototype has been developed as a platform for applied research and engineering evaluation. The system uses multiple parallel microfluidic separations with laser-induced fluorescence detection to measure protein or peptide characteristics. Agents are identified by comparing the sample characteristics to a database by an analytical algorithm running on an embedded microprocessor.

2. System Description
μChemLab™ is an automated, hand-portable, stand-alone, and modular prototypical instrument. With exterior dimensions of 7" x 4" x 5", it occupies approximately 100 in³, weighs 5.5 pounds, and consumes 3.6 watts of power during operation. The instrument contains individual microseparations modules, as shown in figure 1. The current system operates two modules, with room for future expansion. Capillary zone (CZE) and capillary gel (CGE) electrophoresis modules have been demonstrated [3]. Chromatographic separations data are obtained and analyzed within several minutes after sample injection. The menu-driven user interface consists of an LCD display and a four-button keypad. An embedded microprocessor performs system control, diagnostics, data acquisition and analysis. A convectively-cooled enclosure protects all system
subcomponents, and an easily-accessed vibration-isolated platform carries the individual separation modules.

Figure 1: The uChemLab Generation 2 Biotoxin Analyser. Modular system components shown on right including two separations/detection modules and multichannel controller. All subsystems are also now modular. Each microseparations module contains a fused silica microfluidic separations chip, microfluidics electrode/reservoir modules, and an optics module. Internal components are easy to access and replace, and all parts are interchangeable. Simplification of adjustment, conditioning, diagnosis, and component replacement has resulted. Modularity is also intended to simplify future component development and methods implementation.

For example, fluidics modules now use a port geometry generalized for future microchip designs. With better chip and excitation source registration, second-generation optics modules are no longer CZE or CGE specific. Simple module adjustment and alignment supports ready adaptation to any μchip-based method. The 12-channel high voltage boards are easily reconfigured to support any electrokinetic-driven experimentation. New electronic features include a twelve-channel high voltage controller board designed to survive repeated arcs that might result from fluid leaks or device mishandling. Each channel is controlled by a modular daughter board with an electronically controlled potential float feature, bi-polar current capability, and real-time current monitoring, which have improved fluids control during injection and separation. The result has been improved separations quality and greater reproducibility.

In operation, a buffered and labeled protein sample is syringe-injected into the analyzer. The injected sample is transported through the liquid manifold portion of the fluidics module to microchannels in the fused-silica chip. The fluidic manifold interfaces the chip to a sample introduction port, flush port, and sample, sample waste, buffer, and buffer waste fluid reservoirs with electrodes.

New miniaturized chip designs have been developed to improve sample plug geometry, reduce injection loop volumes (to 200 nanoliters), provide filtration at channel inlets, simplify fabrication, and increase chip yields and quality. Reducing sample volumes