BioMEMS-16: MICROCHIP SYSTEM FOR DNA FORENSICS

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Abstract

Under an intensive NIJ-funded project, the Whitehead Institute has developed an automated DNA analyzer to implement STR analysis using nearly standard, thoroughly validated, reagents and protocols. The key advantages are ultra high data quality, ready customization through "application-specific" and disposable chips, ultra high (less than two minute) assay speed - when used in screening mode, and high total sample thoughput. The system is also engineered for future evolution into a portable briefcase-sized system. The standard working element is a16-lane glass microfabricated device which is shown to produce high quality 13-locus STR profiles in each lane (Figure 1).

In this paper we review the status of the final system design as developed for beta testing in the state crime labs in the fall 2001. We also review the microchip DNA analysis protocols as developed under the same program, including current experiments on automated allele calling, confidence scoring, and quantitation of mixtures.

Introduction

Capillary electrophoresis has proven to be an efficient way to analyze forensic evidence, and many forensic analysts are now switching from the slab gel-based techniques to capillary instruments. Still a significant number of DNA samples remain unanalyzed and constitute a huge backlog in the forensic laboratories. In these circumstances, new high-throughput technologies may be of a great importance for the forensic community. In recent years, chip-style analysis has became an attractive alternative to capillary electrophoresis for multiple applications including DNA sequencing and genotyping [1-4]. Our group's first results on ultra-fast analysis of forensic DNA within a microchip device were described in 1997 by Schmalzing *et al.* [5]. In this paper, we present our data for allelic ladders and STR samples multiplexed with PowerPlex 1.2 and PowerPlex16 Promega kits (Figures 2 and 3). We are also evaluating our progress towards building a 16-lane instrument for forensic DNA testing.

Summary

We report the development of a robust and effective method for multiplexed STR analysis within a chip-style microdevice. The method uses a laser-induced fluorescence detection system and simultaneously detects three- and four-color multiplexed PCR samples. Analyses of the eight CODIS STR loci were performed in 20 minutes with single-base-pair resolution ranging from 0.75 – 1. A simultaneous analysis of fifteen loci-ladders and a gender marker Amelogenin based on the PowerPlex™ 16 System was achieved in less than 35 min. The data achieved is of high quality and will assist in important improvements in accuracy and quantitation for forensic analysis.

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Figure 1. STR microchip 16-lane layout with manifold, ports and electrode terminals

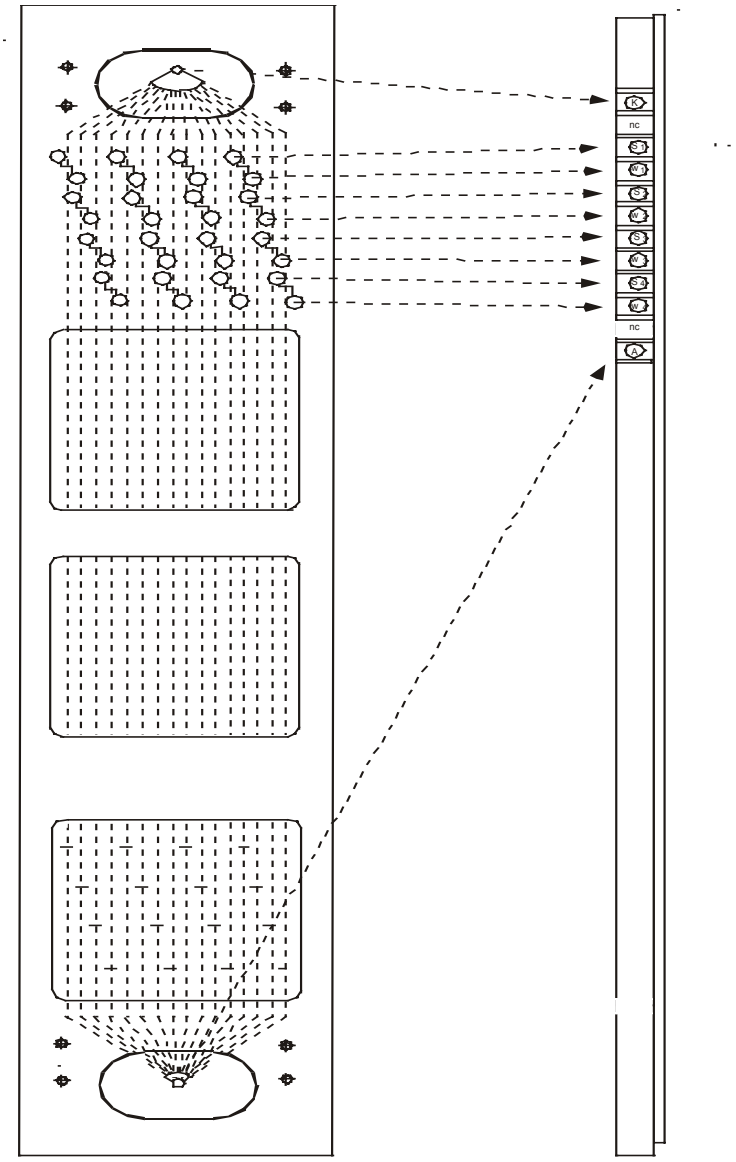

Figure 2. PowerPlex 1.2 allelic ladder

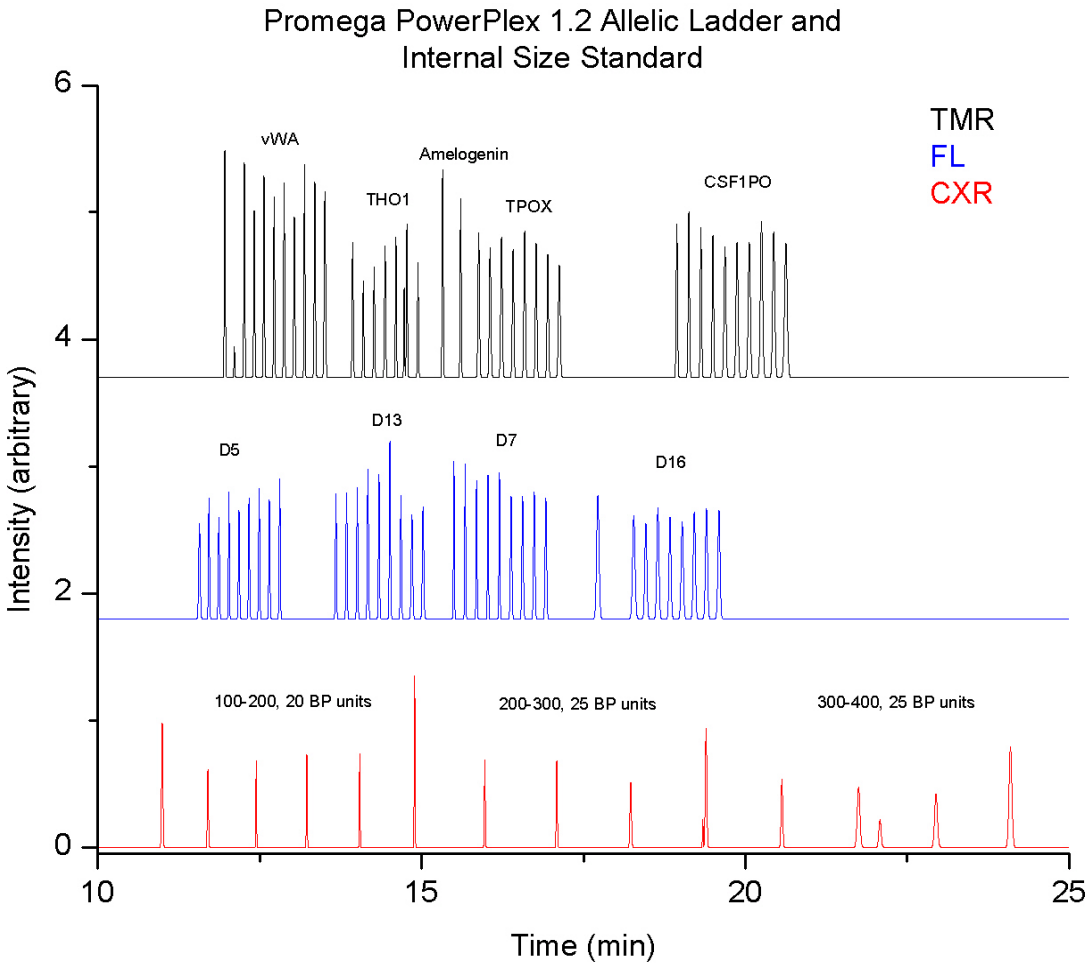

Figure 3. PowerPlex 16 allelic ladder