

# Third Annual IFRI Forensic Science Symposium

International Forensic Research Institute



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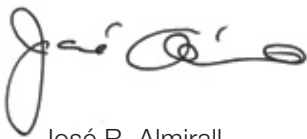
# Third Annual IFRI Forensic Science Symposium

## International Forensic Research Institute

April 30 - May 1

It is with great pleasure that we welcome you to Florida International University for the Third Annual Forensic Science Symposium. This meeting is a continuation of a series of ad-hoc forensic science meetings previously held in South Florida (Nova Southeastern University, Miami-Dade Police, Broward Sheriff, etc.). This year, we expect almost 300 attendees coming from forensic labs, law enforcement, the courts, and industry to join forensic science faculty and students to participate in the symposium. The International Forensic Research Institute is very pleased to host this forum for information exchange that is mutually beneficial to both the forensic science researchers, practicing scientists and the end-users of quality forensic science services. The other aims of this symposium are to provide continuing education opportunities for forensic scientists and to provide the faculty and students an opportunity to showcase their research so that, together, we can coordinate responses to current challenges in forensic casework and ultimately improve the quality of science for the benefit of the legal system and society. This year, the symposium will be offered over two days including a keynote presentation by Dr. John Butler, a world-renowned forensic scientist, five (5) workshops including a workshop on courtroom testimony, 32 oral presentations and 32 poster presentations.

This symposium would not have been possible without the generous support of our collaborators (Miami-Dade Police Department, Broward Sheriff's Office, Palm Beach County Sheriff's Office, Drug Enforcement Administration) and their leadership as well as the corporate sponsors (Qiagen, Agilent, Life Technologies, Eppendorf, The Center for Advanced Forensic DNA Analysis, Field Forensics and Smartwater CSI). We are also grateful to the other forensic laboratories throughout Florida for their participation and to the faculty, staff and students at FIU's International Forensic Research Institute for assistance with the coordination of this event.



José R. Almirall  
Director, International Forensic Research Institute

# Program

## Wednesday, April 30

### New Developments in Forensic Sciences (SIPA 125) — Jose R. Almirall

1:00 – 2:00 p.m.	Registration
2:00 – 2:10 p.m.	Welcome and opening remarks
2:10 – 2:35 p.m.	Development of novel sampling and detection methods for identifying forensic odorants including the use of dogs, birds and elephants — Kenneth G. Furton
2:35 – 3:00 p.m.	Basic Research to Routine Use in the Courtroom: Elemental Analysis and Comparisons of Materials — José R. Almirall
3:00 – 3:30 p.m.	Forensic investigations of animal—human interactions: Animal cruelty and animal attacks — Hector Cruz-Lopez
3:30 – 4:00 p.m.	Towards Fieldable Technologies for Comprehensive Forensic Analysis: Laser Ablation—Microwave Plasma Torch and Multimode Ambient Ionization Mass Spectrometry — Kenyon M Evans-Nguyen
4:00 – 4:05p.m.	Introduction of Keynote Speaker
4:05 – 5:05 p.m.	Keynote speaker: John M. Butler– The National Commission on Forensic Science and the Organization of Scientific Area Committees
5:00 – 5:15 p.m.	Vendor Introductions and Presentations

### 5:15 – 7:00 P.M. RECEPTION AND POSTER SESSION

## Thursday, May 1

### Session 1 – Breakout I: Emerging Forensic Techniques (SIPA 103) — Chairperson: Tate Yeatman

8:30 – 8:50a.m.	An Assessment of the Field Accuracy of Detection Canines using Flowers that Produce the Same Odorant as Cocaine — Michelle Cerreta
8:50 – 9:10 a.m.	Dictyostelium discoideum as a model for cell response and accumulation studies — Kendra Adams
9:10 – 9:30 a.m.	Comprehensive Analysis of Multiple Explosive Compounds — Kelley Peters
9:30 – 9:50 a.m.	Unambiguous Trace Explosives Characterization: Challenges and Perspectives — Alan McKenzie
9:50 – 10:10 a.m.	The discrimination of printing inks by Scanning Electron Microscopy—Energy Dispersive X-Ray Spectroscopy — Ruthmara Corzo

### 10:10 – 10:30 A.M. BREAK

### Session 1 – Breakout II: Tool Mark and Firearms (SIPA 103) — Chairperson: John Mancini

10:30 – 10:55 a.m.	Unique Technologies for Improving Accuracy in Elemental Determinations using ICP—MS in Forensic and Toxicology Application — Amir Liba
10:55 – 11:20 a.m.	SmartWater CSI Forensic Marking Technology: Impact as Crime Deterrent in South Florida and Validation of its Scientific Foundation — Logan Pierson and Tatiana Trejos
11:20 – 11:45 p.m.	Glock Marking Barrels — Gabriel A. Hernandez
11:45 – 12:10 p.m.	The Pen is Mightier than the Sword: a Review of Pen Guns — Erin M. Wilson

### 12:00 – 1:00 P.M. LUNCH

### Session 2 – Breakout I: Drug Analysis/Toxicology (SIPA 100) — Chairperson: Brad Campbell

8:30 – 8:50a.m.	Driving Under the Influence of Drugs in Florida — Nicholas B. Tiscione
8:50 – 9:10 a.m.	Rapid identification of illicit drugs using a comprehensive lab and field—portable toolbox — Patricia Diaz
9:10 – 9:30 a.m.	Communal Assessment of Drugs of Abuse and Identification of their Transformation Products by Online SPE-LC-HRMS — Nubia Heuett

9:30 – 9:50 a.m.	Detecting Target Compounds by GCMS using Deconvolution and Retention Time with Very Large Databases — Fred Feyerherm
9:50 – 10:10 a.m.	Making the right choice for improved assay results How tips, tubes and plates can affect your experiments — Melinda Sheehan

**10:10 – 10:30 A.M. BREAK**

**Session 2 – Breakout II: Drug Analysis/Toxicology (SIPA 100) — Chairperson: Oliver Spicer**

10:30 – 10:45 a.m.	Introduction to “Bath Salts” — Jonia Prieto
10:45 – 12:00 p.m.	Postmortem Forensic Toxicology at the Miami-Dade Medical Examiner Department — Diane M. Boland, George W. Hime, Mary E. Zaney, Theresa Hippolyte, Joe Kahl, and Elisa Shoff
12:00 – 12:15 p.m.	New Approaches to Old Problems via Portable FTIR — Edwin Quintana

**12:00 – 1:00 P.M. LUNCH**

**Session 3 – Breakout I: DNA Analysis and Forensic Laboratory Management (SIPA 125) — Chairperson: Stephanie Stoiloff**

8:30 – 8:50 a.m.	Encode Project: Are CODIS Core Loci Associated With Disease States? — Cecelia Crouse
8:50 – 9:10 a.m.	Something Old, Something New, Something Borrowed, Something (QIA)Blue — Mark Guillianio
9:10 – 9:30 a.m.	The role of alkaline lysis and pressure cycling technology in DNA recovery from mixtures — Deepthi Nori
9:30 – 9:50 a.m.	Paring’ DNA: An innovative way to triage samples — Alyse Yacovone-Margetts
9:50 – 10:10 a.m.	How and Y: Validation and Implementation of POWERPLEX® Y23 for Use on Casework — Brandy Cook

**10:10 – 10:30 A.M. BREAK**

**Session 3 – Breakout II: DNA Analysis and Forensic Laboratory Management ((SIPA 125) — Chairperson: Cecelia Crouse**

10:30 – 10:55 a.m.	The Changing Landscape of Forensic Science - Stephanie Stoiloff
10:55 – 11:20 a.m.	Applying Genome Technology to Forensic Casework — Kevin McElfresh
11:20 – 11:45 p.m.	Bioinformatics for the classification and provenance of soil samples for intelligence and forensic applications — DeEtta K. Mills
11:45 – 12:10 p.m.	Internal Validation of the Quantifiler® Trio DNA Quantification Kit — Joanne B. Sgueglia

**12:00 – 1:00 P.M. LUNCH**

**Workshops**

1:00 – 3:00 p.m.	RDB 1000 — <b>Courtroom Testimony</b>
3:00 – 5:00 p.m.	OE 107 — <b>Designer Drug Analysis</b> — DEA followed by hands-on Designer Drugs Screening using Single Quadrupole GC/ MS and Liquid Chromatography Triple Quadrupole Mass Spectrometry (LC/QQQ)
3:00 – 5:00 p.m.	SIPA 100 — <b>Development and validation of a highly informative quantitative sample assessment system for enhanced casework efficiency</b> — Life Tech
3:00 – 5:00 p.m.	SIPA 103 — <b>Forensic Mixture Analysis: Statistics and Technology</b> — The Center for Advanced Forensic DNA Analysis

## Workshop Abstracts

### ***Development and validation of a highly informative quantitative sample assessment system for enhanced casework efficiency***

Life Technologies

Recently introduced STR kits are highly sensitive, robust and discriminating thereby generating useful STR profiles from previously untypeable samples. Such samples often have low quantity and/or degraded DNA, may contain PCR inhibitors, and, in sexual assault samples, a high quantity of female DNA compared to male DNA. These factors can make it difficult to decide whether to continue with STR analysis, which STR kit to use and how much DNA to add to the STR amplification reaction for obtaining a useful profile on the first attempt. Thus, there is a need for a highly sensitive, robust, and faster method for the assessment of DNA extracts. We describe a new DNA quantification and assessment kit to provide better correlation between the DNA sample and resulting STR profile. This next generation DNA quantification and assessment kit has high sensitivity (sub-pg level), for both the human and male targets, higher inhibitor tolerance to match next generation STR kits and a unique metric for the determination of DNA quality; Degradation Index. The Degradation Index is a quantitative measure of the degree of DNA degradation, useful for the determination of how much DNA to add to the STR reaction and which STR kit to proceed with. The time required to perform amplification has been reduced, to less than one hour. Furthermore, the standard curve generation protocol is optimized to provide consistent results. We have successfully used this system as a decision making tool to obtain complete STR profiles from challenging samples. These samples include trace DNA samples, highly degraded DNA samples, low quantity of male DNA in a high level of female DNA as well as samples contaminated with PCR inhibitors. Data demonstrating how this new quantification and assessment kit provides valuable sample quantity and quality information for making critical decisions in the STR workflow will be presented, illustrating how this approach can facilitate enhanced efficiency and first pass success rates.

### ***Designer Drug Analysis***

Drug Enforcement Administration

There was a time when a “designer drug” was simply a derivative of phenethylamine with mild stimulant and/or hallucinogenic properties. The next wave of synthetics was derived from tryptamine and was primarily hallucinogenic in nature. It wasn’t long before derivatives of delta-9-tetrahydrocannabinol were explored and quickly dismissed in favor of fully synthetic cannabinoids. At nearly the same time, synthetic cathinones appeared on the recreational drug market. And, as history is known to repeat itself, the original phenethylamines have been further re-designed into their very dangerous NBOMe derivatives. This workshop will discuss the evolution of designer drugs and the inherent analytical and legal challenges facing the forensic community.

### ***Forensic Mixture Analysis: Statistics and Technology***

The Center for Advanced Forensic DNA Analysis

This workshop will examine the mechanics of using advanced technology and applying that technology to real case interpretation. Topics related to utilizing technology will be discussed and developing metrics to use the technology in a forensic context will be discussed in detail. Comparisons between STR technology and advanced Genome methods using a forensic casework context will be made. A significant emphasis will be placed on analyzing mixtures, including 2 person, and 3 person mixtures and comparing the results from STR analysis and array based sequence data. Included will be a short review of the process of generating array data and the controls contained in the analytical method. The format is intended to be Socratic with regard to presentation.

### ***Designer Drugs Screening using Single Quadrupole GC/MS and Liquid Chromatography Triple Quadrupole Mass Spectrometry (LC/QQQ) by IFRI-FATF (OE-107)***

IFRI/FATF

This workshop will familiarize the attendees to the recent trends in mass spectrometric techniques that are used for the detection of seized drugs. The gold standard mass spectrometric instrument that is currently in use in many forensic laboratories (GC/MS) will be demonstrated in electron impact ionization as a hands-on experience for a mixture of designer drugs. Also, the attendees will get exposed to the usage of a liquid chromatograph coupled to a triple quadrupole mass spectrometer (LC/QQQ) instrument for the identification of seized drugs with particular attention to designer drugs. Instructors from FIU will present the theory and background information in a short lecture but the emphasis of the workshop will be given to the lab session at the Forensic and Analytical Toxicology Facility (FATF). (Maximum 12 people).

### ***Courtroom Testimony***

Miami Dade Police Department, Palm Beach Sheriff’s Office and the Drug Enforcement Administration

The courtroom testimony workshop will facilitate discussion between the symposium participants and a panel consisting of both current and retired judges as well as regional counsel. Topics covered will include scientific testimony, courtroom/legal terminology, CSI effect, and expert witness testimony.

## Oral Presentation Abstracts

### PLENARY SESSION – WEDNESDAY 2 P.M.

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#### ***Development of novel sampling and detection methods for identifying forensic odorants including the use of dogs, birds and elephants***

Kenneth G. Furton, Florida International University

This presentation describes recent developments in field sampling methods and analytical techniques developed for the rapid detection and identification of characteristic chemicals from forensic specimens. Methods employed include dynamic headspace concentration, Solid Phase Micro Extraction (SPME) and fabric phase sorptive extraction (FPSE) followed by GC or LC separation and mass spectrometric detection to identify characteristic organic compounds. The dynamic headspace sampling method proved to be a useful field instrument for identifying human derived VOCs and also for the preparation of training materials for biological detectors including dogs, birds and elephants. Identified odorants have been used to develop odor mimics as well as a universal calibrant for testing biological and electronic detectors allowing for the comparison of thresholds of detection and improving the sensitivity and reliability. Detection limits are compared for different instrumental and biological detectors with a comparison shown for the ability of dogs, birds and elephants to detect explosives.

#### ***Basic Research to Routine Use in the Courtroom: Elemental Analysis and Comparisons of Materials***

José R. Almirall, Tatiana Trejos, Kiran Subedi, Anna Raeva, Rhett Williamson, Ruthmara Corzo, Florida International University

The chemical analysis and comparison of a number of solid matrices of interest to forensic scientists is made possible by the progression from fundamental research and method development, validation in several forensic laboratories and the publication of international standards. The story of high-sensitivity elemental analysis of materials including glass, paint, soils, precious metals, diamonds, paper and ink on paper begins with the reporting of analytical techniques in the scientific literature and continues with the adaptation and optimization of the analytical methods by forensic scientists to suit these specific matrices. Laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) has been called the “gold” standard for solid-sampling and high-sensitivity elemental characterization of materials providing sub-ppm detection limits of elemental analytes encompassing almost 70% of the periodic table. In addition, LA-ICP-MS provides true quantitative analysis data that can be used in numerical/statistical hypothesis testing to determine “match” and also to populate databases that are useful to determine the probability of a match for a given elemental profile. The story develops further when several forensic laboratories collaborate on method development and optimization as reported by the European Union funded NITECRIME effort (2000-2005) and continued by the NIJ funded Elemental Analysis Working Group (EAWG) effort (2008-2012). The next chapters include interlaboratory trials that report high-quality performance of these methods for the analysis of glass in forensic laboratories and the publication of international (ASTM) analytical consensus standards for the examination these materials. More than 30 forensic laboratories around the world now routinely employ the use of LA-ICP-MS for materials characterization on every continent (except Antarctica) and the history of elemental analysis provides a good model on how forensic method development should progress from basic research to routine use and acceptance in the courtroom.

#### ***Forensic investigations of animal-human interactions: Animal cruelty and animal attacks***

Hector Cruz-Lopez, Ph.D., Florida Fish and Wildlife Conservation Commission

The Fish and Wildlife Forensic Research Laboratory of the Florida Fish and Wildlife Conservation Commission provides criminal investigation support to the agency's Division of Law Enforcement. The laboratory assist investigators and officers in matters concerning protecting Florida's marine, fish, and wildlife resources against illegal harvesting, possession, sale, and harm. During the past year, the laboratory has expanded its capabilities to support investigations concerning animal cruelty, animal attacks, and other interactions between humans and wildlife. This presentation will illustrate a few relevant cases, the challenges, standard operating procedures, and guidelines useful on documenting and analyzing evidence.

#### ***Towards Fieldable Technologies for Comprehensive Forensic Analysis: Laser Ablation-Microwave Plasma Torch and Multimode Ambient Ionization Mass Spectrometry***

Kenyon M. Evans-Nguyen, Hilary Brown, Jennifer Speer, and John Gerling, University of Tampa

This presentation will discuss efforts towards developing instruments using laser ablation and new developments in ambient ionization mass spectrometry for combined elemental/isotopic, inorganic, and organic analyses. In this work, laser ablation (LA) sampling has been combined with microwave plasma torch ionization (MPT) as well as ambient ionization techniques to demonstrate their potential in fieldable mass spectrometry for forensic analysis of materials. In preliminary testing, LA-MPT-MS using a closed sample cell has proven to be an effective technology for elemental analysis. Additionally, laser ablation was successfully coupled to a DART source and intact molecular ions for organic species were generated. When cocaine deposited onto a lead film was analyzed using LA-DART, the intact molecular ion was observed. Further, elemental spectra for the same sample were obtained using LA-MPT-MS. Current work is focused on efficient combination of LA sampling with DART and MPT ionization to yield a single multimode ionization source capable of obtaining molecular and elemental spectra simultaneously.

***The National Commission on Forensic Science and the Organization of Scientific Area Committees (Keynote)***

John M. Butler, National Institute of Standards and Testing

The development of a quality infrastructure for forensic science was a key component of some of the reforms anticipated in the National Academies of Science (NAS) 2009 report entitled "Strengthening Forensic Science in the United States: A Path Forward." In response to the NAS report, the National Institute of Standards and Technology (NIST) and the US Department of Justice (DOJ) signed a bilateral agency Memorandum of Understanding (MOU) in March 2013 which specified the establishment of a National Commission on Forensic Science (NCFS) and development of "Guidance Groups" now termed Scientific Area Committees (SACs). NCFS membership was announced in January 2014 and the first Commission meeting was held February 3-4, 2014 in Washington, DC. From over 300 applicants, thirty-seven individuals were selected to achieve a diversity of experiences, including Federal, State, and Local forensic science service providers; research scientists and academicians; Federal, State, Local prosecutors, defense attorneys and judges; law enforcement; and other relevant stakeholders. The Commission is led by co-chairs James Cole, Deputy Attorney General, and Dr. Patrick Gallagher, NIST Director and Acting Deputy Director for the Department of Commerce. Nelson Santos, Deputy Assistant Administrator for the Office of Forensic Sciences at the Drug Enforcement Administration, and Dr. John Butler, Special Assistant to the Director for Forensic Science, serve as the DOJ and NIST Vice-Chairs, respectively. The NCFS is a federal advisory committee for DOJ and as such follows prescribed rules that include public meetings and a balance of perspectives. Commissioners come from 21 states and represent: professors of biochemistry, chemistry, pathology, physics, sociology, statistics, and law (including a Nobel laureate and National Medal of Science recipient); crime laboratory directors (FBI, DEA, ATF, USPS, DoD, VA DFS, LASD, PBSO); judges, prosecutors, and defense attorneys; and a sheriff, detective, coroner, medical examiner, victims' advocates, and defendants' rights advocates. All NCFS meetings are public and materials are available at <http://www.facadatabase.gov/> (enter NCFS name or commission number: 83353). NIST developed the Organization of Scientific Area Committees (OSAC) to administer and coordinate support for the discipline-specific SACs (see <http://www.nist.gov/forensics/osac.cfm>). In September 2013, NIST issued a Notice of Inquiry (NOI) in the Federal Register to obtain national and international input on the establishment and structure of governance models. Eighty-two submissions were received in response to the NOI. The OSAC is designed to provide uniform administration for development, promulgation, and adoption of documentary standards in the forensic science community. While NCFS is a DOJ advisory group to enact policies, OSAC will be an on-going community effort to improve forensic practices through developing documentary standards that can be used by accrediting bodies in future audits of forensic laboratories. This presentation will review progress made with NCFS and OSAC.

**SESSION 1: EMERGING FORENSIC TECHNIQUES – THURSDAY 8:30 A.M.**

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***An Assessment of the Field Accuracy of Detection Canines using Flowers that Produce the Same Odorant as Cocaine***

Michelle Cerreta, B.S.\*, Kenneth G. Furton, Ph.D., Florida International University

In recent years, canine detection has been under scrutiny. For example, during the Supreme Court case, *State of Florida v. Jardines*, it was stated that if a canine alerts to the active odor signature that the canine associates with the contraband, and not the contraband itself, which has been previously cited, the canine's accuracy and selectivity is under question, since many of these compounds have been found in common household products. Specifically, methyl benzoate, the volatile organic compound (VOC) associated with cocaine, has been found to be the most abundant compound produced by snapdragon flowers. Therefore, the question arose whether a canine would falsely alert to a snapdragon flower if a canine alerts to methyl benzoate. The purpose of this study was to examine the VOCs released from newly grown snapdragon flowers, primarily methyl benzoate, and assess its potential at eliciting a false alert from specially trained detector canines. A canine's ability to distinguish between unfamiliar pools of odor which resemble the illicit substance, like those produced by snapdragon flowers, as well as the potential of a false alert in a similar field scenario, was examined.

***Dictyostelium discoideum as a model for cell response and accumulation studies***

Kendra J. Adams, John D. DeBord, Christopher J. Thompson, Richard H. Gomer, Francisco Fernandez-Lima, Florida International University

Exposure to controlled substances, ingestion and accumulation present a significant analytical challenge because of the chemical complexity of biological substances. The basis of any biological response relies on how specific cell types react and change when subjected to external stimuli as a function of time and dose. In the present study, *Dictyostelium discoideum* cells are used as a biological model to generate a better understanding of at the single cell level of how cells respond and adapt as a function of external stimuli. A unique advantage of *D. discoideum* is that they can shift between single celled and multicellular organisms based on the external stimuli. Wild type *D. discoideum* cells were studied at the mature phase and after 6 hours of starvation to characterize the macromolecular differentiation using high-resolution mass spectrometry followed by statistical analysis. In the first phase, a baseline for molecular and macromolecular differentiation of *D. discoideum* was established. In a second stage, molecular differentiation as a function to exposure to controlled substances will be assessed. Latency period, molecular markers and biological regeneration/degradation rates upon exposure will be studied.

***Comprehensive Analysis of Multiple Explosive Compounds***

Kelley Peters, Chloe de Perre, Bruce R. McCord, Ph.D., Florida International University

In recent years, there has been a dramatic increase in the use of improvised explosive devices (IEDs) due to improved controls placed upon commercial and military explosives. Because of the wide range of volatility, polarity, and composition of IEDs, no single method has been developed to simultaneously analyze them. It is the goal of this study to develop one comprehensive method in order to quickly identify multiple explosive compounds. This method utilizes infusion based electrochemical detection ESI-TOF MS and 18-crown-6 ethers in order to produce complexes with inorganic ions (ammonium nitrate, urea nitrate, potassium chlorate, and ammonium perchlorate). These inorganic salts can then be successfully detected as ion pairs in positive ion mode while still permitting the analysis of other high explosives, such as TNT, RDX, and HMTD. An electrochemical detector placed before the mass spectrometer permits the determination of H<sub>2</sub>O<sub>2</sub>, an analyte normally difficult to detect through mass spectrometry.



### ***Unambiguous Trace Explosives Characterization: Challenges and Perspectives***

Alan McKenzie Coe, John Daniel DeBord, Mark Ridgeway, Melvin Park, Gary Eiceman and Francisco Fernandez-Lima, Florida International University

In the present study, trapped ion mobility spectrometry coupled to mass spectrometry (TIMS-MS) and theoretical calculations have been used to study the tridimensional space of explosive molecular ion with various adduct forms. The unique capability of TIMS-MS for the separation and identification of trace amount of explosive compounds from complex mixtures with commonly known interferences is demonstrated. In particular, collision cross sections were measured for four standard explosive compounds and their adduct forms. It is shown that the use of solution dopants (e.g., ammonium salts) increases the confidence value and selectivity for the detection of explosive compounds. For the first time, the molecular ion relative stability of different adduct forms was studied using single molecule, gas-phase ion-neutral kinetic measurements. The results of which can potentially be used for the profiling of explosives compounds in conjunction with other parameters measured in this experiment i.e. mass-to-charge, and ion mobility.

### ***The discrimination of printing inks by Scanning Electron Microscopy-Energy Dispersive X-Ray Spectroscopy***

Ruthmara Corzo, Florida International University

With the availability of affordable, high-quality printers constantly being introduced in the market, document counterfeiting has become increasingly problematic. As such, more sophisticated methods of analysis are necessary in order to determine the authenticity of a questioned document. The elemental analysis of the printing ink may provide valuable information that would allow the analyst to discriminate two ink samples or make an inference about a common source. Scanning Electron Microscopy-Energy Dispersive Spectroscopy (SEM-EDS) is a technique that is readily accessible in many laboratories and has the advantages of being non-destructive as well as offering both elemental analysis and imaging capabilities. In this study, a total of 319 ink specimens comprising four types of printing ink (toner, inkjet, offset, and intaglio) were analyzed by SEM-EDS and qualitatively compared using spectral overlay. The elemental analysis of the toner inks resulted in a discrimination of 97.2%. In the case of toners, SEM imaging allows for the comparison of particle morphology, which can be useful for the differentiation of two inks that are indistinguishable by their elemental profile.

### ***Unique Technologies for Improving Accuracy in Elemental Determinations Using Icp-MS in Forensic and Toxicology Applications***

Amir Liba and Bert Woods, Agilent Technologies Inc., Little Falls Site, 2850 Centerville Rd., Wilmington, DE 19808, USA, Agilent Technologies

Quadrupole based ICP-MS instruments have been successfully applied across a wide variety of inorganic analyses from the clinical and nutritional to the environmental and forensic applications. However, some small important limitations in key applications remain unsolved despite the numerous improvements in technology and operating conditions in the past 25 years.

While many spectral interferences on key analytes such as arsenic, selenium, vanadium etc have been addressed successfully using modern ICP-MS instruments equipped with collision/reaction cell (CRC) technology, today there are still some elements in a small number of applications that still suffer from these interferences. If you are in the minority, these limitations can affect the accuracy of the data and lead to wrong conclusions.

The recently introduced ICP-QQQ has a unique configuration with an additional quadrupole placed before the reaction cell. The first quadrupole selects the ions that enter and react in the cell, eliminating the variability and uncertainty associated with single-quad reaction mode, and delivering unmatched performance and flexibility for interference removal. The ICP-QQQ uniquely provides collision/reaction cell (CRC) operation with controlled reaction chemistry.

The new ICP-QQQ delivers consistent and reliable results even when the sample composition is complex or variable.

### ***SmartWater CSI Forensic Marking Technology: Impact as Crime Deterrent in South Florida and Validation of its Scientific Foundation***

Logan Pierson<sup>1</sup>; Tatiana Trejos<sup>2</sup>, Ph.D. and José R. Almirall<sup>2</sup>, Ph.D, <sup>1</sup>President, SmartWater CSI LLC, Fort Lauderdale, Florida 33301 USA

<sup>2</sup>Department of Chemistry and Biochemistry and International Forensic Research Institute, Florida International University, Miami, Florida 33174 USA

SmartWater is a colorless liquid that fluoresces yellow under ultra-violet (UV) light. Each batch of SmartWater is made from metal-based chemicals under its patented forensic technology with a unique and identifiable taggant 'code' that is registered in the SmartWater database to a specific owner address/location. It provides a credible and proven source of evidence, and has a 100% conviction rate in the United Kingdom Courts of Law. SmartWater is accredited by the British Standards Institute (BSI PAS820:2012) as a laboratory-identifiable forensic code, and the International Organization for Standardization accredits the SmartWater database for information security management (ISO 27001). The Ft. Lauderdale Police Department credits the use of SmartWater products with a reduction in burglaries of 14% over the last year and a collaboration with the Broward Sheriff's office was initiated in August 2013 [1].

The IFRI Institute at FIU has previously validated the scientific foundation of the methods of recovery and analysis of these chemical tagging systems using both LA-ICP-MS and LIBS [2]. Mock cases and 150 coding samples were measured as "blind specimens" to evaluate the discrimination potential and error rates of the method when the chemical signatures detected by LA-ICP-MS were compared to the company's database. This study demonstrated that SmartWater products represent an effective tagging source due to its high discrimination potential, selectivity, ease of recovery and persistence on objects and that LA-ICP-MS and LIBS can be used to effectively detect these traceable taggants to assist law enforcement agencies.

1. Police chief credits SmartWater with role in burglary reduction, Sun Sentinel, March 24, 2014 by Don Crinklaw, <http://www.sun-sentinel.com/news/broward/fort-lauderdale/fl-esb-smartwater-0320-20140324,0,2793703.story> accessed on April 7, 2014.

2. S Wise, and JR Almirall, Chemical Taggant Detection and Analysis by Laser Induced Breakdown Spectroscopy (LIBS), Applied Optics, 2008, 47(31) G15-G20.

### ***Glock Marking Barrels***

Gabriel A. Hernandez, M.S., Miami-Dade Police Department

Glock is a major firearms manufacturer. They supply weapons to many law enforcement entities including the Miami-Dade Police Department (MDPD). Standard Glock barrels typically do not leave markings suitable for identification on the bearing surface of fired bullets. However, barrel designs were created through collaboration with the MDPD firearm and toolmark examiners to solve this forensic problem for law enforcement personnel who carry Glock firearms. This presentation will cover the newest iteration of a barrel design made by Glock which is being marketed as the "Glock Marking Barrel." Furthermore, a test was produced using four consecutively made Glock Marking Barrels. The test was given to trained firearm and toolmark examiners to evaluate their ability to identify bullets fired through these barrels. There were no false identifications reported. Also, an evaluation of potential sub-class characteristic carryover in reference to these barrels will be discussed.

### ***The Pen is Mightier than the Sword: a Review of Pen Guns***

Erin M. Wilson, MFS, Miami-Dade Police Department

While rare, pen guns are occasionally submitted to the Miami-Dade Crime Laboratory as evidence. The design and size of certain types of pens make them conducive to single-use with .22 caliber ammunition. Because of the non-threatening and concealable nature of a pen, this type of homemade (zip) gun is even more dangerous. This presentation will examine the inner mechanics of several pen guns maintained by the MDPD Firearms Reference Collection as well as a sampling of other unique zip guns.

## **SESSION 2: DRUG ANALYSIS/TOXICOLOGY – THURSDAY 8:30 A.M.**

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### ***Driving Under the Influence of Drugs in Florida***

Nicholas B. Tiscione, M.S., Xiaoqin Shan, Ph.D., Dustin Tate Yeatman, M.S., Palm Beach County Sheriff's Office

This study highlights one of the challenges with combating the incidence of driving under the influence of drugs (DUID) in Florida. Unlike the majority of states within the United States, the laws in Florida for DUID list specific compounds (controlled drugs) that must be proven to cause the observed impairment. Many prescription and over-the-counter drugs that can cause significant impairment are not included in this list. Therefore, according to Florida law, one is not guilty of driving under the influence if the observed impairment is due to a drug not listed in the Florida Statutes. Blood and urine samples in most jurisdictions in the state are not tested for non-controlled drugs, so this problem is not well documented. In contrast, Palm Beach County analyzes and reports all impairing substances regardless of the scheduled status of the drug. Over the past seven years, 25% of all drug positive blood specimens and 46% of all drug positive urine specimens contained at least one non-controlled drug, often mixed with controlled drugs. The driving under the influence charges were dropped or not even filed in many if not most of those cases with non-controlled drugs.

### ***Rapid identification of illicit drugs using a comprehensive lab and field-portable toolbox***

Patricia Diaz, Ph.D., Jean Vincenti, B.S., Michael Kayat, Ph.D., Field Forensics, Inc.

A streamlined process for illicit drug identification complying with SWGDRUG guidelines is presented. Field Forensics, Inc. offers a toolbox to law enforcement and crime laboratories comprising portable Raman spectroscopy, ruggedized thin layer chromatography, and colorimetric test kits. The toolbox is applied to both the processing of conventional drugs of abuse and new psychoactive substances (NPS) including synthetic cannabinoids and substituted cathinones. NPS have recently presented problems for laboratories including the lack of established analysis standards and the overwhelming number of analog variants. Analysis times are significantly decreased and integrating this toolbox into a laboratory operation would improve efficiency. The toolbox is also uniquely suited for use by law enforcement personnel and even enables crime laboratories to provide guidance on best practices. Obtaining reliable identification based on accepted standards at the investigative level would assist in reducing backlogs, with suspects potentially accepting plea agreements before cases reach the laboratory for analysis.

### ***Communal Assessment of Drugs of Abuse and Identification of their Transformation Products by Online SPE-LC-HRMS***

Nubia V. Heuett, Cesar E. Ramirez, Sudha Rani Batchu and Piero Gardinali, Florida International University

Wastewater analysis by LC-MS has become the main technique for non-intrusive evaluation of drug consumption in communities. However, monitoring of drugs of abuse (DOAs) has neglected multiple phase I and II transformation products (TPs) that could reveal higher usage of DOAs. An online-SPE-LC-HRMS method was developed to monitor the consumption of 18 DOAs in a college campus. A QExactive™ Orbitrap was used in full-scan (R=140,000) for quantitation of DOAs and screening of TPs, which were identified using targeted-MS2 (R=35,000). MDLs for parent DOAs were 0.1 to 0.8 ng/L. Sixteen DOAs were detected with the most frequent being amphetamine and benzoylecgonine reaching concentrations of 5,068 and 804 ng/L respectively. Identification, confirmation, and quantitation of 56 phase I and II TPs was achieved (≤4.2 ppm). Mole fractions show that 9 of the identified metabolites were more abundant than their parent DOAs and thus could be used as main targets for routine monitoring.

### ***Detecting Target Compounds by GCMS using Deconvolution and Retention Time with Very Large Databases***

Fred Feyerherm, Agilent Technologies

A very powerful tool for detecting target compounds in complex matrices has been developed. This tool uses deconvolution in conjunction with very accurate retention times. Multiple large databases are available including Forensic Toxicology and Controlled Substances. This tool has been shown to be effective in a number of laboratories including law enforcement, medical examiners, and clinical.

***Making the right choice for improved assay results How tips, tubes and plates can affect your experiments***

Melinda Sheehan, Ph.D., Eppendorf

It has been known for several years that chemicals (e.g., Bisphenol A and phthalates) can leach out of plastics, such as water bottles and have a negative impact on human health. Recent scientific reports have now noted that chemicals used in the manufacturing of disposable plastic labware, such as slip agents or plasticizers, can leach out of the plastic and affect laboratory experiments leading to erroneous results. This presentation will discuss the current scientific findings on leaching and the impact they can have on lab experiments. In addition, benchmarking data from several different tubes available on the market will be shown to support the scientific findings. These findings may be of particular interest to forensic scientists as the integrity of their results is of the utmost importance. Eppendorf has eliminated the use of several common additives during the manufacturing of their tubes, tips, and plates, to minimize the impact on scientific assays. Unexpected leachates have the ability to influence results of experiments ultimately affecting the outcome of the case by introducing doubt to the certainty of your results.

***Introduction to "Bath Salts"***

Jonia Prieto and Oliver S. Spicer, Jr., M.S., Miami-Dade Police Department

The use of new psychoactive synthetic substances as recreational drugs has raised concern over the last few years. In an attempt to avoid legal prosecution, new designer drugs have been marketed as "bath salts" when they in fact contain synthetic chemicals that mimic the pharmacological effects of commonly abused controlled substances like cocaine, LSD, ecstasy and amphetamines. Synthetic derivatives of cathinone are usually found in these drugs. Both the law enforcement community and health care professionals indicate that synthetic stimulants are growing in popularity because they can be easily obtained and because of the perception that they pose a seemingly safer alternative to illegal methods of getting "high." Due to their potential threat to public safety, we will be discussing the general facts about synthetic cathinones, as well as the most prevalent of these now illegal compounds submitted to the Analytical Section of the Miami-Dade Police Department Forensic Services Bureau (FSB) for analysis. An overview of the history, appearance, effects, and legality of "bath salts" will be presented.

***Postmortem Forensic Toxicology at the Miami-Dade Medical Examiner Department***

Diane M. Boland, George W. Hime, Mary E. Zaney, Theresa Hippolyte, Joe Kahl, and Elisa Shoff, Miami Dade Medical Examiner

Postmortem forensic toxicology has evolved into one of the most challenging of the forensic sciences due to the nature of the evidence under investigation, the complexity of cases received, and the development and onslaught of new complex pharmaceutical and potent illicit drugs. Over the years, the Toxicologists at the Miami-Dade Medical Examiner Department have also evolved to better meet the demands and analytical challenges of postmortem cases received today. As outlined in the mission statement of the Toxicology Laboratory, the main purpose is "to provide quality postmortem forensic and analytical toxicology services"; this includes detecting complex toxic chemicals, whether prescription or illicit, at very low concentrations and with a high degree of reliability and accuracy.

The focus of this presentation is to convey the role that Toxicologists play in death investigation at the Miami-Dade Medical Examiner Department. The importance of investigative information, including decedent's social and medical history, behavior at the terminal event, scene description and photographs, along with the autopsy results and toxicology testing will be emphasized. The operational procedures, both administrative and technical, as well as the analytical protocols, the unique nature of the evidence under investigation, and analytical challenges will be discussed and applied to case examples. In addition, three challenging areas of postmortem toxicology (inhalants, synthetic cathinones, and synthetic cannabinoids) will be presented.

***New Approaches to Old Problems via Portable FTIR***

Edwin Quintana, Agilent Technologies

Infrared spectrometers first commercialized during WWII for the identification of synthetic polymers have seen dramatic changes in the last five years. Today, driven by application needs, Infrared Spectroscopy is experiencing a rebirth with the development of small, rugged, portable, handheld spectrometers changing the paradigm of having bringing samples back to the laboratory for analysis. Because of advances in optoelectronics and miniaturization, Michelson interferometer based portable FTIRs can now be used in forensics to outside confines of the laboratory to take nondestructive measurements directly at the investigation scene. Hazardous spills, paint transfers, accelerants, and controlled substances can all be analyzed using portable spectroscopy by field investigators to acquire valuable and actionable information while at the scene. In this talk, we will focus on field forensic applications of out of lab FTIR. We will cover the identification of coatings and paint residue using handheld FTIR. We will show how FTIR can be used to quickly identify designer drugs including closely related structure such as isomers.

**SESSION 3: DNA ANALYSIS AND FORENSIC LABORATORY MANAGEMENT – THURSDAY 8:30 A.M.**

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***Encode Project: Are CODIS Core Loci Associated With Disease States?***

Cecelia Crouse, Palm Beach County Sheriff's Office

In 1996, the FBI Laboratory organized a Short Tandem Repeat working group for the purpose of validating, and in 1997, selecting what are now known as the thirteen CODIS STR loci. The STR loci were chosen based on results from the bench laboratory effort and because they were located in non-protein coding regions of the genome, did not manifest as a phenotype and were not related to a disease state. Since 2000, ENCODE scientists (Encyclopedia of DNA Elements) were pouring over the sequenced human genome and in May 2012 reported that 80% of the human genome has a biochemical function thus discrediting the theory that non-coding genes are “junk DNA”. In June 2012 in a Vermont courtroom, an evolutionary biologist for the defense testified “that there was an association between one or more of those loci and particular medical conditions” making “those loci disease predictive” and the judge agreed. The purpose of this presentation is to expose the participants to the “junk DNA” debate.

***Something Old, Something New, Something Borrowed, Something (QIA)Blue***

Mark Guillianio, Qiagen

This presentation will focus on (1) solutions offered from QIAGEN's Applied Testing Genetic Identity and Forensic portfolio and (2) supporting data obtained from real, functioning Forensic DNA laboratories that have chosen QIAGEN customer solutions to process their DNA samples. The instruments and chemistries described throughout will highlight the various approaches (both old and new) available and chosen by forensic DNA laboratories. The incorporation of the techniques described within this presentation will enable the adoption of standardized, validated methods to improve productivity and expand lab functionality. The presentation will demonstrate that leveraging current resources and employing appropriate automation at key steps will provide a custom, lab-specific solution sure to maximize laboratory efficiency.

***The role of alkaline lysis and pressure cycling technology in DNA recovery from mixtures***

Deepti Nori\*, MFS; Bruce R. McCord, Ph.D, Florida International University

Sexual assault cases are plagued by challenges in sample analysis due to the presence of tissue from multiple contributors. The objective of this study is development of a method using pressure cycling technology (PCT) combined with reagents to selectively disrupt sperm or epithelial cells and recover DNA. The extraction procedure is performed utilizing the Barocycler® NEP 2320, a commercially available instrument from Pressure Biosciences Inc. (South Easton, MA), equipped with a hydrostatic pressure chamber that generates alternating cycles of ambient and high pressures with a range of 5- 45 kpsi. Another goal of this study was to enhance sample recovery from cotton swabs in the presence of alkaline conditions.

Preliminary results indicate that the application of pressure cycling technology, in the presence of appropriate buffers, can result in 50-60% recovery of male DNA from mixtures. Careful optimization of parameters including NaOH concentration, incubation time and temperature resulted in 5-6 fold enhancement in the relative ratio of sperm DNA in these mixtures.

***'Paring' DNA: An innovative way to triage samples***

Alyse Yacovone-Margetts, Palm Beach County Sheriff's Office

The Palm Beach County Sheriff's Office evaluated the LGC Forensics ParaDNA® Screening Instrument with the Screening Kit as a tool to predict the quality of DNA profiles. Forensic DNA laboratories are experiencing a backlog of casework due to an influx of requests to process all cases and all samples that contain biological evidence. DNA analysis is a time consuming and expensive process and in some cases a sample may not yield an interpretable profile or even a quantifiable amount of DNA. This evaluation was performed in order to determine if the laboratory could limit the number of low quality samples it analyzes. The results from the ParaDNA® instrument were compared with traditional STR analysis to determine if a correlation could be made between the ParaDNA® result and the expected STR profile. Results indicated that the ParaDNA® instrument may serve as a useful tool in the prioritization of evidentiary samples.

***How and Why: Validation and Implementation of Powerplex® Y23 for Use on Casework***

Brandy Cook, Forensic Scientist, Palm Beach County Sheriff's Office

The Palm Beach County Sheriff's Office Forensic Biology Unit (FBU) recently validated and implemented the PowerPlex® Y23 System for use on casework. The PowerPlex® Y23 System is a 23-loci, 5-color Y-STR multiplex system designed for genotyping forensic samples containing male DNA. The majority of the validation studies were contracted out to Sorenson Forensics of Salt Lake City, Utah. The results of the validation demonstrated that the PowerPlex® Y23 System is a sensitive, robust, and reliable method for Y-STR testing. In addition, after benchmarking other forensic laboratories utilizing Y-STRs, the FBU created a decision tree which guides Y-STR requests through a case acceptance policy. The validation, training, implementation, and casework acceptance policy for Y-STRs will be discussed.



### ***The Changing Landscape of Forensic Science***

Stephanie Stoiloff, M.S., Miami Dade Police Department

In 2009, the National Academy of Sciences (NAS) released a report entitled *Strengthening Forensic Science in the United States: A Path Forward*. In March 2014, Senator John Cornyn co-sponsored the latest version of Senator Patrick Leahy's proposed legislation aimed at addressing some of the recommendations described in the NAS report. In the time leading up to the recently introduced Leahy-Cornyn bill, a separate piece of forensic legislation has been drafted by Senator Rockefeller. In February 2013, a National Commission on Forensic Science was established via a Memorandum of Understanding between the Department of Justice and the National Institute of Standards and Technology to focus on forensic science policy. In February 2014, the creation of a Forensic Science Standards Board and the Organization of Scientific Area Committees was announced to focus on the practice of forensic science. The question remains: which pathway is best for the future of forensic science?

### ***Applying Genome Technology to Forensic Casework***

Kevin McElfresh, Ph.D. and Jodi Bailey, Center for Advanced Forensic DNA Analysis

As the forensic analyst is asked to solve tougher cases the need for more diverse and precise data becomes paramount. One particular example of this situation is the analysis of mixture samples. It is possible in some limited instances to identify individuals within a mixture using STR methods and analytical software. More advanced molecular methods are available and can be applied to address difficult forensic samples and mixtures in particular. Specifically, the use of SNP arrays to assess the DNA sequence differences between samples. In order to apply advanced molecular methods to forensic casework, the methods must be validated using the accepted guidelines. This means that the results of hundreds of thousands of data points need to be distilled into forensic reports. Data presented here will examine the use of SNP arrays on forensic samples and the interpretation and presentation of those results.

### ***Bioinformatics for the classification and provenance of soil samples for intelligence and forensic applications***

Natalie Damaso, Julian Mendel, Maria Mendoza, DeEtta K. Mills, Florida International University

Based on the ecological hypothesis that the soil type determines which microbes live in a soil, it should be possible to use soil metagenomic profiling to produce a unique biotic pattern and associate it to the collection site. The questions are: 1. Is there a correlation between the soil's genetic profile and the geographic location? 2. Can these predicted patterns be used for soil provenance? The first question was answered using a Mantel test for spatial autocorrelation of metagenomic data from four taxa --bacteria, archaea, fungi, and plant—using  $\approx 1200$  soil samples from Miami-Dade County, FL. Question 2 has been answered using bioinformatics algorithms that can be trained on the known biotic profiles and then can predict an association of a random sample to the soil type. These approaches can link the soil biotic profiles to its provenance and can be used for either intelligence or forensic purposes.

### ***Internal Validation of the Quantifiler® Trio DNA Quantification Kit***

J.B. Sgueglia, S.J. Skancke, C.D. Paintner, J.L. Elliott, J.N. Roth, Life Technologies

Validation of the Quantifiler® Trio kit includes the following studies: Contamination, Sensitivity and Stochastic, Precision: Repeatability, Precision: Reproducibility, Accuracy: NIST SRM 2372, Mixture, Non-Probative Samples, and Standard Curve and Control Metrics. Results from in-house internal validation studies will highlight the use of multi-copy targets and the significant increase in sensitivity (sub-picogram level). Data for both low and high DNA concentrations will be evaluated for reliability and repeatability. Reproducibility of concentrations across quantification plates will be assessed for the standard dilution series and several genomic DNA sample dilutions. Accuracy of NIST 2372 Standard Reference Material® component concentrations will be measured by comparison to the values listed in the Certificate of Analysis. The mixture study will demonstrate that minor male DNA can be reliably and reproducibly detected in the presence of excess female DNA. Results from non-probative sample types, representative of routine forensic samples encountered in casework, will be described. The qualitative information provided by the kit includes not only the presence of inhibitors but the degree of DNA degradation. Additionally, downstream STR analysis of select samples will be presented.

Validation and implementation of this kit will enable laboratories to obtain critical quantitative and qualitative information to make decisions regarding downstream STR processing (i.e., not to proceed with amplification, or amplify with autosomal STR and/or Y STR). An additional application may include sample screening for the presence of male DNA to determine if casework samples, such as sexual assault evidence, will provide probative information.

## Poster Abstracts

### ***Evaluation of Human Scent As Possible Classification Evidence***

Lauren J. Colón-Crespo, B.Sc.\*, Danay Herrera-Hernández, Howard Holness, MBA, Abuzar Kabir, Ph.D., Kenneth G. Furton, Ph.D., Florida International University

Past work evaluating human scent has shown that it can be used to differentiate individuals based on their characteristic volatile organic compounds (VOCs), making it a useful form of forensic evidence. This has aided in the resolution of court cases by providing investigators with the ability to associate victims and offenders based on human scent left at crime scenes. In the present research we investigate whether human scent can also be employed to classify individuals that share traits which contribute to their scent profiles and cause them to display similarities. In this study, individuals from different age groups were recruited, their body odor was sampled and their characteristic VOC profiles were analyzed by Headspace SPME-GC-MS. Once collected, the profiles obtained were evaluated to determine which components provided information on how age could be used as a criterion for the categorization of individuals based on their VOC profile. This presentation will emphasize the way in which information obtained from the combination of features in a VOC profile could be employed to highlight links between individuals that share specific traits (age).

### ***Fast detection of gunshot residues on the hands of suspects by Laser Induced Breakdown Spectroscopy (LIBS) and Capillary Microextraction of Volatiles (CMV) GC-MS***

Anamary Tarifa and José R. Almirall, Florida International University

Gunshot residue (GSR) could become relevant trace evidence in terrorist attacks and other criminal activities involving firearms. Gunshot residues can be deposited on the shooter's hands (or other people in the immediate vicinity) and other objects in nearby areas around the discharged firearm. Gunshot residues are composed of organic and inorganic components. Volatile organic compounds originate from unburned or partially burned gunpowder, while inorganic compounds are residues originate mainly from the primer. Analysis of GSR is typically performed by SEM-EDS (inorganics) or SPME-GC-MS (organics). Although useful for identification of GSR, these methods are time consuming and not adaptable for rapid onsite sampling and screening. In this study, two fast screening methods were developed and optimized for the detection of inorganic and organic compounds. The proposed method for the extraction of volatile organic compounds in GSR is done by a capillary microextraction of volatiles (CMV) device followed by detection using a gas chromatography coupled to a mass spectrometer. This novel sampling technique promises to yield fast results (< 1 min. sampling) for the detection of volatiles associated to the presence of GSR, on the hands of a person suspected of recently firing a firearm. In addition, a fast LIBS screening method for the detection of inorganic compounds indicative of GSR presence, such as Antimony (Sb), Lead (Pb) and Barium (Ba), is proposed here. Advantages of LIBS include ultrafast analysis (< 5 seconds/shot) and high selectivity and sensitivity, with expected LODs of 5 ppm, 7 ppm and 0.4 ppm for Pb, Sb, and Ba respectively. The analytical performance of the LIBS method is compared to previously reported methods such as Inductively Coupled Plasma – Optical Emission Spectroscopy (ICP-OES) will also be presented

### ***Forensic analysis and comparisons of white latex paints using LA-ICP-OES without matrix-matched standards***

Melissa Zwilling, José R. Almirall, Florida International University

Latex paint samples may be encountered as transfer evidence in forensic casework. Infra-red analysis is commonly used to differentiate paint binders, but does not discriminate paint sources. Quantitative and comparative elemental analysis using LA-ICP-OES requires minimal sample preparation and has been previously developed in our group for other matrices. [Schenk] However, these methods require matrix matched-standards, since ablation rates and laser coupling can vary with matrix. The proposed method will eliminate the need for matrix-matched standards by simultaneously introducing a solution of known concentration with sample ablation of the unknown. Houk previously described the use of this standard addition method for other matrices. Solution is mixed with solid ablation, both with known concentrations, but the solid need not match the matrix of the sample. Results presented here demonstrate calibration curves with  $R^2 \geq 0.99$  in most cases and good sensitivity. The development of quantitative analysis without the need for matrix-matched standards will open up the field of laser ablation to the analysis of many other matrices where matrix-matched standards do not currently exist.

### ***Ambient Ionization Mass Spectrometry for Simultaneous Detection of Organic and Inorganic Components of Gunshot Residue (GSR) and Explosives***

Jennifer Speer, Brian Sanchez, Hilary Brown, Kenyon Evans-Nguyen, University of Tampa

An analytical method capable of detecting both inorganic and organic components simultaneously, with little sample preparation, is being studied using Desorption Electrospray Ionization (DESI) and Direct Analysis in Real Time (DART) coupled with Laser Ionization-Mass Spectrometry (LIMS). In preliminary experiments, black powder, a common explosive used in IED construction, and 50 ng of CsCl, an analog of a likely radionuclide for an RDD, were added to a polypropylene mesh swab and analyzed using DESI coupled to an ion trap mass spectrometer. The black powder fuel (ascorbic acid) and oxidizer (nitrate and perchlorate) as well as the cesium were detected simultaneously. In more recent experiments, LIMS has been incorporated into the ionization source and used for analysis of refractory materials. Current research is focused on development of a multi-mode LIMS and DART source for simultaneous detection of organic gunshot residues (e.g., diphenylamine) and inorganic lead, barium, and antimony oxides.

#### ***A Mass Spectrometer for Elemental Analysis based on Fieldable Technologies***

Hilary Brown, Jennifer Speer, John Gerling, and Kenyon Evans-Nguyen, University of Tampa

Laser ablation (LA) can facilitate direct analysis of solid samples for mass spectrometry (MS), and is often coupled with an inductively coupled plasma torch (ICP). LA-ICP-MS is now widely used for accurate elemental and isotopic analysis; however, the technique is not fieldable, primarily due to the gas and power requirements of the ICP torch. A mass spectrometer system for elemental and isotopic analysis using technology that is amenable to portable instrumentation is being studied. Solid samples are being ablated with an excimer laser and the resulting particle and ion plume will flow through a microwave plasma torch (MPT) and into an ion trap mass spectrometer. Preliminary data confirms that using laser ablation directly coupled with an ion trap mass spectrometer is a viable technique for detecting metals (e.g., lead, cobalt) and refractory compounds (e.g., strontium titanate). Current efforts are focused on enhancing sensitivity by incorporating a custom MPT. While we anticipate that LA-MPT-MS will have somewhat reduced sensitivity relative to LA-ICP-MS, MPTs, laser ablation and ion trap mass spectrometers can all be incorporated into portable instruments.

#### ***Development of an improved extraction and analysis technique for human scent evidence analysis***

Philip Davis, B.S., Abuzar Kabir, Ph.D. and Kenneth G. Furton, Ph.D., Florida International University

The human body produces odors made up of a variety of volatile organic compounds (VOCs), which are a class of chemical compounds that have high vapor pressures at room temperature. The combination of these VOCs in different abundances produces a scent which is different for each individual. The current standard for the analysis of VOCs from human scent samples is headspace solid phase microextraction (HS-SPME), followed by gas chromatography-mass spectrometry (GC-MS). In this experiment, a dynamic headspace method was developed for the extraction of human scent compounds. A standard mixture of compounds that have been previously observed in human scent samples was prepared and spiked onto cotton gauze. This mixture was then extracted using dynamic headspace extraction, and analyzed using GC-MS. These results were compared to results obtained using SPME-GC-MS. The dynamic headspace method was able to extract a wider range of compounds and greater extraction efficiency was achieved.

#### ***Enhancement of Human Scent Detection through the use of Exhaustive Liquid Extraction Methods***

Danay Herrera-Hernández \*, Lauren J. Colón-Crespo, B.Sc., Howard Holness, MBA, Kenneth G. Furton, Ph.D., Aixing Fan, Ph.D., and Laurence Du-Thumm, Ph.D., Florida International University

In this study, underarm odor samples were collected from individuals of different age groups and gender. After collection, the samples were extracted using both HS-SPME and liquid extraction procedures in order to obtain a complete image of the scent profile. HS-SPME was used to gather the VOC fraction of the profile, while the liquid extraction was responsible for the collection of those components that are less volatile yet are significant contributors to the overall scent profile. Once the extraction of the different fractions of the scent profiles was completed, both extracts were analyzed using gas chromatography mass spectrometry (GC-MS). The profiles obtained from the analyzed samples were evaluated to determine whether they showed components that may provide information on how age and gender could be used as criteria to categorize individuals based on their scent. /

#### ***Detection of the Laurel Wilt Pathogen for the Protection of Avocado Groves***

Alison G. Simon, B.A., B.S., Kenneth G. Furton, Ph.D., DeEtta K. Mills, Ph.D., Florida International University

The invasive and fatal laurel wilt pathogen caused by *Raffaelea lauricola* is advancing through the Lauraceae family in the southeastern United States, most notably in the Florida commercial avocado groves. Its vector is the exotic redbay ambrosia beetle (*Xyleborus glabratus*), which inoculates the tree 2-4 weeks before any physical symptoms are seen. The optimal method for early detection of some fungal diseases is canines, which are often used in law enforcement, including in ports-of-entry to prevent the entry of illegal meats or agricultural items. However, novel threats cannot be stopped using this port-of-entry method. This research focuses on identifying the volatile organic compounds above the laurel wilt pathogen in infected trees through SPME-GC-MS with the goal of creating a controlled odor mimic permeation system (COMPS) with which to train canines to locate the pathogen so the diseased trees can be removed and healthy trees protected.

#### ***Simultaneous Chiral Separation of 12 Cathinone Analogs by Cyclodextrin-assisted Capillary Electrophoresis Time-of-Flight Mass Spectrometry***

Hanzhuo Fu, Gustavo Merola, Franco Tagliaro, Teodora Macchia and Bruce R. McCord, Florida International University

In this study, a rapid chiral separation of 12 cathinone analogs has been developed and validated using cyclodextrin-assisted capillary electrophoresis (CE) with UV/Vis and time-of-flight mass spectrometric (TOF-MS) detection. All analytes were separated within 18 minutes in the CE-UV separation and identified by TOF-MS. 10 compounds were chirally separated using  $\gamma$ -cyclodextrin in the UV mode and an additional 2 more were chirally separated using highly sulfated- $\gamma$ -cyclodextrin in the MS mode. Detection limits down to 1.0 ng/mL were obtained. This method provides high resolution separation and quantification by CE-UV and exact mass identification of individual analytes present in the mixture by TOF-MS. The low injection volume permitted by CE will make this method useful in forensic laboratories when a minimal sample input is required. To the author's knowledge, this is the first published report of cathinone analogs separated and detected by both CE-UV and CE-TOF-MS.

***Voltammetric detection of 3,4-methylenedioxymethamphetamine (MDMA) using a glassy carbon electrode chemically modified with cucurbit[6]uril.***

Maraine Tadini, Gregoire Demets, Bruce R. McCord, Marcelo de Oliveira., Florida International University

3,4-methylenedioxymethamphetamine (MDMA) is a psychotropic drug that is most often found in ecstasy tablets. Cucurbiturils are highly symmetric molecules that exhibit a barrel-shaped structure. They bear carbonyls oriented outward and a hydrophobic central cavity that can form inclusion compounds with some species. The goal of this study aimed to develop an electrode chemically modified with cucurbit[6]uril (CME) to detect MDMA and compare its response with a conventional glassy carbon electrode(GCE). To prepare the electrode, the glassy carbon surface was modified with a film containing CB[6], Nafion, and methanol, using dip- and spin- coating techniques. Voltammetric experiments were conducted at MDMA concentrations ranging from  $4.2 \times 10^{-6}$  to  $4.8 \times 10^{-5}$  mol L<sup>-1</sup>. The CME prepared by spin-coating presented lower LOD and LOQ values. It detected MDMA with higher sensitivity when compared with conventional GCE electrodes under the studied experimental conditions. When compared with literature data on the performance of conventional GCE electrodes using pulsed techniques, the developed CME afforded improved sensitivity and is a good alternative to detect MDMA in seized samples.

***Determination of cocaine by Cyclic Voltammetry using Platinum as working electrode: a comparative study between modified surfaces***

Erica Oiye, Maria Fernanda Ribeiro, Maraine Tadini, Laura de Oliveira,Marco Balbino, Izabel Eleoterio, Matheus Menezes, Jose Fernando de Andrade, Bruce R. McCord, Marcelo de Oliveira, Florida International University

Voltammetric techniques have provided good results for the analysis of cocaine over the last 20 years. The aim of this work is to compare the results between two different surface coatings applied to platinum electrodes for the detection of cocaine. Our research group has recently reported on the application of cobalt hexacyanoferrate and Uranyl Schiff base films. In the first experiment, a decrease in anodic and cathodic current peaks in a reversible interaction between the analyte and the film is observed. For the second experiment, there is an increase in both current peaks, and probably the mechanism for this process is the same. For both films, analytical curves were established for a linear response for cocaine. The parameters studied were dynamic range, linearity of response, accuracy, precision, and detection and quantification limits. The effect of different matrices and analytical conditions were also discussed. The goal of the project was to develop rapid and sensitive techniques for screening of this drug in seized samples by police.

***Analysis of seized samples of marijuana after colorimetric spot tests using differential pulse voltammetry***

Marco Balbino, Izabel Eleoterio, Jose Fernando de Andrade, Bruce R. McCord, Marcelo de Oliveira, Florida International University

Marijuana is the most widely trafficked and consumed illicit drug in the world. Electrochemical methodologies can also be employed for illicit drug analyses, being usually less expensive than conventional techniques (i.e., chromatographic or spectroscopic ones) and offering the possibility of portable devices. In this context, this work aims to propose a fast, and less expensive voltammetric methodology for detection and quantification of  $\Delta^9$ -tetrahydrocannabinol ( $\Delta^9$ -THC) in sized samples, even after the specimen is subjected to colorimetric test. The Differential Pulse Voltammetry technique was applied using a conventional glassy carbon disc as working electrode, tetrabutylammonium tetrafluoroborate (TBATFB) 0.10 mol L<sup>-1</sup> as supporting electrolyte (in N,N-dimethylformamide medium) and anodic stripping potential in -0.5 V (30 s). The anodic peak current in  $\pm 0.01$  V increases linearly with  $\Delta^9$ -THC concentration. The presence of the Fast Blue B does not interfere in the voltammetric analysis of  $\Delta^9$ -THC. Results indicated good linearity over concentrations from 1.0 nmol L<sup>-1</sup> to 5.0 nmol L<sup>-1</sup>, with a LOD of  $2.88 \times 10^{-10}$  mol L<sup>-1</sup> and a LOQ of  $1.0 \times 10^{-9}$  mol L<sup>-1</sup>.

***Analysis of Methylphenidate (Ritalin) and Ritalinic Acid in Oral Fluid by Liquid Chromatography-Triple Quadrupole Mass Spectrometry (LC/QQQ-MS)***

Luis Arroyo-Mora, Carmen Mulet, Haixiang Yu, Taylor Ginley and Anthony P. DeCaprio, Florida International University

Methylphenidate (MPH) is an amphetamine derivative commonly used in the treatment of attention-deficit hyperactivity disorder (ADHD) in children, adolescents and adults, a condition affecting 3-5 % of the U.S. population. MPH is rapidly absorbed after oral administration and becomes hydrolyzed to its main metabolite ritalinic acid (RA). Ritalin has become in recent years one of the most frequently abused prescription drugs. For example, college students use it as a "study drug". Due to its potential for abuse, development of non-invasive monitoring methods is important. Here we present the assessment of a commercial oral fluid collection device to evaluate oral fluid as an alternative biological specimen for the analysis of MPH and RA. Quantitative determination was achieved by using a liquid chromatograph coupled to a triple quadrupole mass spectrometer. A robust and fast LC/QQQ method (five minutes) was developed following a simple dilute and shoot approach.

***Validation of Amplified Fragment Length Polymorphism (AFLP) Profiling of Forensically Important Insects***

Fanchen Bao, Jeffrey Wells, Florida International University

Amplified fragment length polymorphism (AFLP) has been introduced to forensic entomology recently to study population genetics of forensically important flies. However little work has been done to demonstrate the reproducibility and robustness of the technique. We found that mismatch error rate, a measure of AFLP reproducibility, did not significantly differ among different genomic DNA quantities (50, 100, or 500 ng), suggesting a wide range of appropriate DNA input quantity. Comparison of mismatch error and population genetic results (AMOVA and SPAGeDi) between DNA sources revealed that DNA extracted from head was not significantly different from thoracic tissue. However, choice of capillary electrophoresis (CE) platform (310 vs. 3130xl) had a considerable effect on AMOVA and SPAGeDi, most likely due to peak shift in 3130xl. Choice of thermocycler (MultiGene vs. RotorGene) had an effect on SPAGeDi, but not on AMOVA. These results suggested that AFLP was reproducible across varying quantities or sources of DNA, but not across different instruments.



***Biochemical and biophysical properties of positively supercoiled DNA***

Andrea Berrido\*, Andrew Chen, Jin He, Yuk-Ching Tse-Dinh, and Fenfei Leng, Florida International University

Here we studied the biophysical and biochemical properties of the positively supercoiled DNA under different conditions. Large amount of (+) supercoiled DNA is difficult to obtain compared to the natural-occurring (-) supercoiled DNA. Therefore, the biochemical and biophysical properties have not been fully explored. In the proposed studies, we will utilize *Archaeoglobus fulgidus* DNA reverse gyrase, which will be expressed in *E. coli* strain BL21(DE3)/pLysS and purified using an optimized purification scheme, to convert the (-) supercoiled plasmid DNA to the (+) supercoiled DNA. The (+) supercoiled DNA will be further purified by the CsCl-EB density-gradient centrifugation. After we obtained a few milligrams of the (+) supercoiled DNA template, biochemical and biophysical properties will be characterized using different techniques, such as UV melting, circular dichroism, AFM (atomic force microscope), fluorescence spectrometry, DNA topoisomerase assays, and etc. Our results are expected to provide the basis for the utilization of the (+) supercoiled DNA for future biomedical applications, such as the use of (+) supercoiled DNA templates for the screening of anti-gyrase antibiotics.

***Fluorescent Random Amplified Microsatellites (F-RAMS) Analysis of Mushrooms as a Forensic Investigative Tool***

Beatrice Kallifatidis, Jan Borovička, Jana Stránská, Jiří Drábek, DeEtta K. Mills, Florida International University

Under most forensic circumstances the standard method for proving illegal distribution of hallucinogenic mushrooms is chemical analysis of the indole alkaloid contents. In this study, we tested a DNA based approach, Fluorescent Random Amplified Microsatellites, for profiling mushroom evidence to species and sub-species level and aiding forensic investigations. Thirty seven mushrooms of the genera *Amanita* and *Psilocybe*, including 15 *Amanita rubescens* samples, were profiled using two fluorescently labelled degenerate primers, 5'DD(CCA)5 and 5'DHB(CGA)5, targeting different microsatellite repeat regions. The amplicons were separated using a 310 Genetic Analyzer and analysed using the Genemapper® v.4.0. The 5' DHB (CGA)5 primer provided more reliable data for identification purposes, by grouping samples of the same species and clustering closely related species together in a dendrogram based on amplicon similarities. Intra-specific variation between the 15 *A. rubescens* samples was shown with both primers and all amplicons were organized into discriminant, private, and marker amplicons, based on their individualizing potential.

***ParaDNA® Intelligence System Validation (USA)***

Beatrice Kallifatidis M.S., Julian Mendel M.S., Nicholas Tribble Ph.D., Stephen Blackman Ph.D., Angela Florn, DeEtta K. Mills Ph.D., Florida International University

The ParaDNA® Intelligence System has been designed to provide a five loci STR profile from a range of crime or reference samples, directly, without prior processing, in approximately 75 minutes. In addition, the sex of the sample donor is determined. Allele detection is performed by Polymerase Chain Reaction (PCR) and melt curve analyses using fluorescent HyBeacons™ technology. The purpose of the system is to triage samples, indicate which samples are best for STR analysis and provide tactical intelligence to aid in the investigation. Using an innovative sample collector, minimal training is required to enable investigators to collect, and analyse DNA. This poster presents the validation data that indicate the potential utility of the ParaDNA® Intelligence System in the United States, by profiling several mock evidence samples: touch/skin (fingerprints, phones), saliva (water bottles, cigarettes, swabs) and blood.

***Biodiversity of cel48 gene across Miami-Dade County soils***

Priyanka Kushwaha, Jacqueline Zayas, Yanie Oliva, Maria Mendoza, Beatrice Kallifatidis, and DeEtta K. Mills, Florida International University

Microbial diversity in soils can aid in forensic soil comparisons. Soil profiling of microorganisms using metagenomics will assess the dynamic microbial community. The objective of this study was to compare the microbial diversity of functional cellulase gene (*cel48*) across Urban Land-Udorthents (soil type 1) and Lauderhill Dania-Pahokee (soil type 2) of Miami-Dade County, Florida. DNA was extracted from samples collected from four transects belonging to each soil type. Degenerate primer for *cel48* was used to amplify the gene using polymerase chain reaction followed by cloning and sequencing. Sequences were analyzed by BLAST and subsequently aligned to construct a phylogenetic tree. Results indicate that function of *cel48* was conserved within the two soil types. Majority of the clones from both the soil types grouped together with the clones of their respective soil type. Thus, suggesting use of *cel48* as functional marker to compare soil types in concert with other soil metagenomic signatures.

***Breed designation for unknown equine case samples***

Ketaki Deshpande, Natalie Leyva, DeEtta K. Mills, Florida International University

The plethora of unsolved horse slaughter cases in the Miami-Dade and Broward counties of Florida is a testimony to the gravity of the situation. In equine forensic there is a tremendous need to develop methods that will supplement individual identification with breed designation in the identification of unknown samples. The current case study illustrates the use of population genetic statistical software STRUCTURE 2.3.1 for breed identification of an equine slaughter case in Miami-Dade County, Florida. By performing admixture analyses using all available breed allele frequencies, the new RMP was based on Standardbred, Lipizzaner, Arabian and Tennessee Walker breeds using published genotypes resulting in more discrimination and a better RMP with each breed. We will present a case study as an example to recommend the use of admixture software to determine the breed of horses for forensic match calculations.

***Analysis of Trace Organics at Parts per Trillion Level Concentrations Using a Novel Sample Preparation Technique: Fabric Phase Sorptive Extraction***

Rodolfo Mesa, B.Sc.\*, Abuzar Kabir, Ph.D., Kenneth G. Furton, Ph.D., Florida International University

After attending this presentation, attendees will understand the working principle, advantages and potential applications of the recently developed sample preparation technique known as fabric phase sorptive extraction (FPSE) in preparing forensic samples for instrumental analysis. This presentation will impact the forensic community as well as scientists interested in analyzing trace organic analytes in food, pharmaceutical, biological, environmental and toxicological samples of forensic significance by providing a simpler and inexpensive sample preparation technique capable of handling original samples without any matrix clean-up which is equally effective both in the laboratory as well as in the field. The current study consisted of FPSE on water samples containing five of the 16 EPA PAH priority pollutants at 200 parts per trillion level concentrations. To the best of the author's knowledge, this is the first report of the direct extraction of PAHs at 200 ppt level concentration in solvent-less microextraction and analysis using HPLC-UV.

***Quantitative Analysis of Designer Drugs in Oral Fluid Using Liquid Chromatography Triple Quadrupole Mass Spectrometry (LC/QQQ-MS)***

Ana-Michelle J. Broomes, Carmen T. Mulet, Luis E. Arroyo-Mora, and Anthony P. DeCaprio, Florida International University

The use of oral fluid as an alternative specimen for the detection of drugs of abuse is increasingly important within the forensic, clinical and toxicological fields. We present a quantitative analytical method for the detection of several recently DEA scheduled designer drugs. Synthetic cannabinoids were included as part of the model compounds to evaluate the applicability of the oral fluid as an alternative biological specimen for the rapid assessment of recent drug intake. A solid phase extraction method using polymeric cartridges was used for sample clean up and enrichment. A dynamic multiple reaction monitoring (dMRM) method in a triple quadrupole mass spectrometer was implemented for the mass spectral characterization of multiple designer drugs. The advantage of using multiple transitions is also suggested as a fingerprint mass spectral tool for unambiguous identification of the target compounds. Figures of merit including selectivity, linearity, limit of detection, and recovery are reported.

***Qualitative Screening of Multiple Designer Drug Classes using Polymer Based SPE and LC-QTOF-MS.***

Joshua Z. Seither, Luis E. Arroyo, and Anthony P. DeCaprio, Florida International University

Recently there has been an increase of recreational designer drug use among drug users. Due to potential dangers and legal implications that arise from the use of such drugs, it is important that forensic toxicology laboratories have the capability to screen and detect as many designer drugs as possible. In order to address the dynamic nature of designer drug use and to screen for these drugs effectively, many laboratories have turned to mass spectrometric screening techniques such as the LC-QTOF-MS. The LC-QTOF-MS enables the analyst to have higher confidence when identifying a compound, due to its high resolution, high mass accuracy and MS/MS capabilities. This project focuses on creating and validating a screening method that employs a polymer based cation mixed mode extraction cartridge for sample preparation and an Accurate-Mass QTOF LC/MS for sample analysis.

***Differentiation of Synthetic Cathinone and Synthetic Cannabinoid Regioisomers by GC-QQQ-MS/MS***

Seongshin Gwak and José R. Almirall, Florida International University

The abuse of synthetic cathinones and synthetic cannabinoids has been proliferated worldwide with the ease of acquisition through the Internet or head shops. Despite the efforts to regulate these psychoactive substances, new designer drugs continue to emerge. The identification of designer drugs is often challenged due to their similar structures and the presence of positional isomers resulting in very similar mass spectral profiles in electron ionization (EI) mass spectra and insufficient information for identification. In this study, the mass spectrometric differentiation of several synthetic cathinone and synthetic cannabinoid regioisomers is performed by gas chromatography triple quadrupole tandem mass spectrometry (GC-QQQ-MS/MS) with EI and chemical ionization (CI) modes. The discrimination of regioisomers is achieved by obtaining the product ion scan mass spectra at different collision energies, 10, 20, and 30 V. As a result of collision induced dissociation of precursor ions, with nitrogen as a collision gas, the peaks for product ions are presented with different relative abundances in their mass spectra depending on the regioisomers.

***Novel Polymer for Bioseparations of Complex DNA Mixtures using Capillary Electrophoresis***

Natalie Damaso, Priyanka Kushwaha, and DeEtta K. Mills, Florida International University

Objective: A critical need exists to develop a method that can rapidly analyze mixed DNA profiles by length and sequence polymorphisms without the need for metagenomic sequencing. Method: The commercial polymer, POP-4 and a novel polymers, F-108, PVP/HEC, and G-gels, will be compared using capillary electrophoresis (CE) to determine the best matrix for separating and detecting the obscure sequence diversity within length-based amplicons, modeled using mixed microbial genomes. Results: F-108 polymer displayed the best results while PVP/HEC illustrated similar results to POP-4 and G-gels were not reproducible. Significance: Novel polymers can provide a 2-D resolution of mixed profiles based on length and sequence differences. This will greatly impact the forensic community by assisting in mixture interpretation and even for the identification of harmful pathogens/biothreat agents, a critical need for Homeland Security.

***A Comparison of Thermal Fingerprint Development to Known Chemical Techniques on Porous Surfaces***

Thaddeus Mostowtt, Robert Ramotowski, Florida International University

Although heat has been used to develop latent prints in the past, recently published material has renewed interest in this visualization method. The Thermal Fingerprint Developer 2 (TFD-2), an automated device that uses heat to produce fluorescent prints on porous surfaces, was recently introduced. An evaluation of this new thermal method was conducted in three phases. In phase I, the optimal conditions (scan speed, power setting, number of scans) for the TFD-2 instrument were determined. In Phase II, a direct comparison using split depletion prints was conducted between the TFD-2 and several common operational visualization techniques for porous surfaces (1,2-indanedione-zinc, ninhydrin, and PD). In Phase III, the impact of incorporating the TFD-s in standard latent print processing sequences was evaluated. Overall, Phase II results indicated that conventional chemical processes outperformed the TFD-2. Phase III results indicated that using the TFD-2 first in a processing sequence could adversely affect the success of subsequent treatments.

#### ***Identification of Projectiles to a Crosman Air Rifle***

Angela L. Garvin, M.S, Miami Dade Police Department

A .177 caliber Crosman air rifle and fired pellets from a homicide case were submitted to the laboratory. Velocity testing was requested to determine if the submitted air rifle had the capability of being the weapon used. The fired pellets were identified to the submitted air rifle.

#### ***Automatic Decoding and Manual Decryption of a Smith & Wesson Sigma Serial Number Barcode***

Yamil Garcia, Miami Dade Police Department

A Smith & Wesson Sigma Series pistol with an obliterated serial number was received in casework. The laser etched serial number was unable to be restored through physical and chemical restoration methods. Automatic decoding and manual decryption was then performed on the bar code above the serial number with success.

#### ***Bioinformatics Tools for the Classification of Soils in Forensic Applications***

Julian Mendel, Natalie Damaso, Maria Mendoza, Yanie Oliva, Ashley Diaz, Giri Narashiman and DeEtta K. Mills, Florida International University

Soil a dynamic substrate and sample type, is often encountered in forensic cases. It contains both abiotic and biotic information that is highly correlated to soil type. Therefore, soil metagenomic profiling should produce unique soil biotic patterns. In this study, four taxa, bacteria, archaea, fungi, and plants, were amplified using LH-PCR and unique profiles were obtained for 1269 soil samples. Supervised machine learning tools, using R programming language, were assessed to classify soils into soil type, transects and season of sampling. Biotic profiles as well as abiotic data obtained from the USDA were used. The overall goal of this technique was to be able to train algorithms to distinguish patterns, so that an unknown soil can be correctly classified, therefore obtaining soil provenance. Results showed that biotic and abiotic data had high classification accuracy across all tools for soil type. However, biotic data outperformed abiotic at transect and season level.

#### ***Placing a statistical probability on a time-since-death estimate based on categorical data.***

Anne E. Perez, Neal H. Haskell, Jeffrey D. Wells, Florida International University

We developed the first statistical test for estimating postmortem interval (PMI) from categorical (e.g. presence/absence) data. An implication of those calculations was that published field experiments using either human cadavers or nonhuman surrogates employed insufficient replication. This study produced the first empirical model for associating a probability with a PMI estimate. The analysis was based on insect data, but the methods work for any categorical postmortem observation. 53 pig carcasses (16±2.5 Kg) were exposed during three consecutive summers at a site in Indiana. Each carcass was randomly assigned to a wooded location and sampled daily for a 14 days, by which time all carcasses were skeletonized. Daily occurrence was recorded for 266 species, of which 17 were found to be common enough for statistical analysis. Predictive models based on the three most common species gave a preliminary assessment of the precision possible when calculating PMI from insect succession data.

#### ***Development of Paper Microfluidic Devices for the Rapid, On-Site Detection of Multiple Explosives***

Kelley Peters, Inge Corbin, Micale Kaufman, Kyle Zeribe, Bruce R. McCord, Florida International University

In recent years there had been a dramatic increase in the use of improvised explosives. These materials have a wide range of volatility, polarity, and composition, so multiple analyses must be run in a lab in order to identify the explosive material. This process increases the amount of time before any information on the identity of the explosive can be provided to on-site personnel. Therefore, military and law enforcement personnel need a rapid, inexpensive, simple method in order to identify these types of materials in the field. The use of paper microfluidics (μPADs) allows for the development of very inexpensive devices based on designs printed in wax-based ink on chromatography paper and colorimetric test reagents. Two different μPADs have been designed: The inorganic explosive μPAD is capable of detecting chlorate, perchlorate, ammonium, nitrate, and nitrite while the high/organic explosives μPAD is capable of detecting nitroaromatics, nitroamines, H<sub>2</sub>O<sub>2</sub>, and urea nitrate.

#### ***Development of a Surface-Enhanced Raman Spectroscopy Method for the Detection of Benzodiazepines in Urine***

Erika L. Doctor, M.S. and Bruce R. McCord, Ph.D., Florida International University

Benzodiazepines are commonly present in many toxicological screens. Currently these compounds are analyzed using immunoassay techniques; however more specific screening methods are needed. This project shows the applicability of surface enhanced Raman spectroscopy as a method for the analysis and detection of benzodiazepines. The procedure involves mixing urine extracts with gold nanoparticles and aggregating agents for detection of these compounds. Eleven benzodiazepines were examined. Work by this laboratory has shown that for benzodiazepines an aggregate solution made of MgCl<sub>2</sub> prepared at a concentration of 1.67 M provided the highest signal intensity at the lowest drug concentration. The supported liquid extraction method specific for benzodiazepines used was found to allow for the detection of a wide variety of benzodiazepines. The presence of individualizing spectral peaks provides a high degree of specificity for sample determination. The technique is sensitive with a limit of detection of 5 ng/mL and linear over several orders of magnitude.

#### ***An Assessment of Different Extraction Techniques for the Detection of Odorants Released from Synthetic Cathinones***

Vanquilla Shellman, B.A.\*, Howard Holness, Ph.D, and Kenneth G. Furton, Ph.D., Florida International University

Bath salts (methylenedioxymethamphetamine and MDPV) are formed by changes to the core cathinone structure. Replacing ecstasy in enforcement encounters, the distribution of these drugs has resulted in emergency scheduling [1]. Over the years, canines have detected concealed substances by using their noses to detect the volatile organic compounds (VOCs). Ongoing research reveals that these VOCs are indicators to the active compounds present [2,3]. However, little research that has been performed on identifying the compounds released from synthetic cathinones. The purpose of this study is to identify a technique to extract the VOCs released from bath salts. A comparison of two different extraction techniques, thermal desorption and solid phase micro-extraction (SPME), was conducted on a several bath salt samples. Several gauze pads were placed over the samples for a week and analyzed. It was concluded that SPME extracted a wider variety and higher abundances of the VOCs potentially emanating from the bath salts.



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