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WHITE PAPER

# Field-Based Raman Spectroscopy:

## Legal Precedence and Potential Impact on Prosecution for Narcotics Identification

By David E. Bugay, Ph.D. and Michael Cipoletti, M.S.

### Introduction

Law enforcement officers responsible for reducing narcotics trafficking and drug abuse have many challenges. The war on drugs is not slowing down; in fact, new drugs are appearing on street corners and in high schools every day.

The judicial process from arrest to prosecution can be lengthy and costly to taxpayers. After an arrest, narcotic-specific test kits are typically used to obtain a positive indication for presumptive evidence. Unfortunately, for some of the newer, more exotic drugs of abuse, such as synthetic cathinones or "bath salts," specific test kits may not be available yet. While narcotic-specific kits can be used in the field or within a controlled environment, such as a police station, seized samples are subsequently sent to a state laboratory for confirmatory testing. Overburdened laboratories can extend this process for weeks, or even months, before test results reach the prosecutor's hands. The burden and stress placed on chemists to process samples as quickly as possible can be substantial.

State-of-the-art analytical techniques relied on for confirmatory analysis are now being miniaturized and simplified for operation, and making their way into field instrumentation.

The transition from lab-based to field-based analyzers allows users to conduct the same reliable measurements at the point of arrest, reducing the burden on crime labs and accelerating the prosecution process. One of the analytical techniques transitioning from the laboratory to the field is Raman spectroscopy.


This document provides background on Raman spectroscopy's solid technical foundation and a brief introduction to a new handheld Raman instrument for narcotics identification. Bringing narcotics identification from the lab to the field will help enable faster prosecution while reducing costs.

### Raman Spectroscopy Fundamentals

Raman spectroscopy is a well-established, highly sensitive analytical technique that can be used to analyze solids, liquids, and gases. It falls into a class of analytical techniques that are sensitive to the vibrations of atoms in molecules, referred to as vibrational spectroscopy. Infrared spectroscopy (IR) is another vibrational spectroscopy technique; both Raman and IR have been used in forensic laboratory instrumentation for decades due to their high specificity and low false alarm rates.

Providing a significant advantage, Raman spectroscopy is sensitive to the chemical structure of a material and can consequently be used to identify a sample. Organically-based

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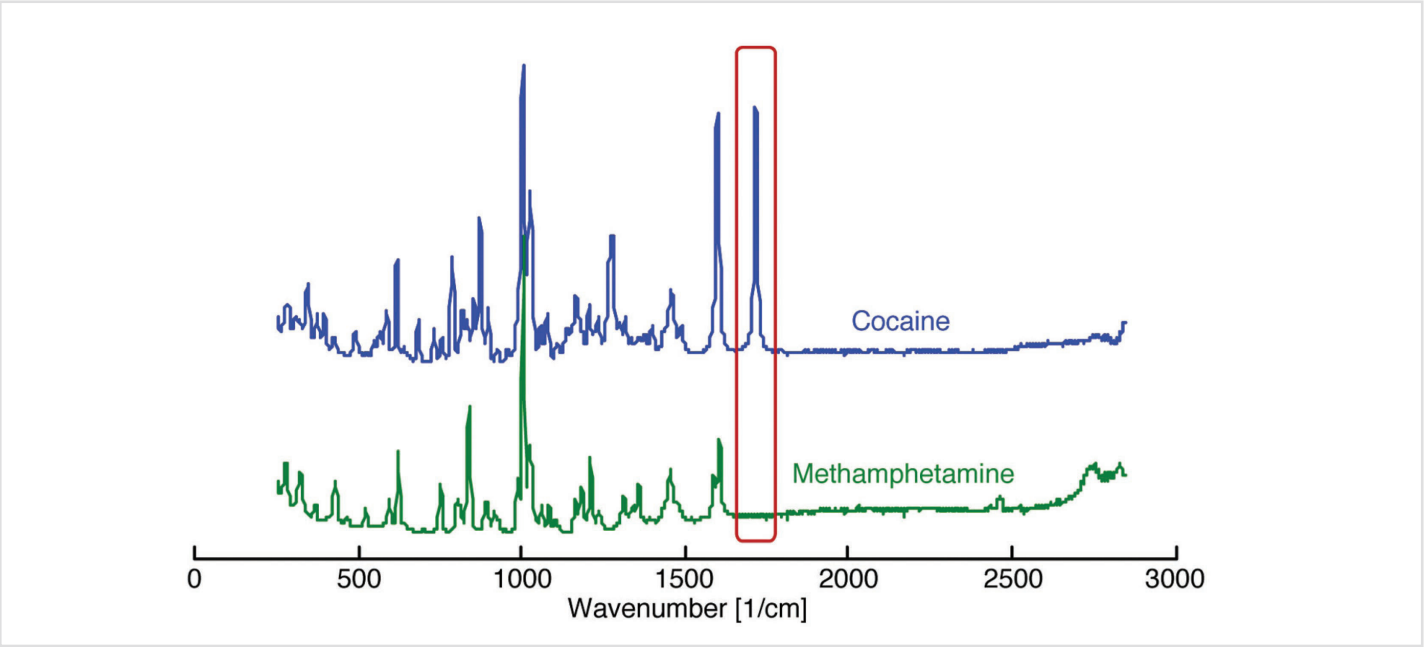


**Figure 1. Raman spectra for cocaine and methamphetamine.**

chemical compounds, such as drugs of abuse, vibrate at discrete frequencies. The number and frequency of these vibrations depend primarily on the number of atoms in the chemical compound and how these atoms are connected via specific chemical bonds. Because the types of atoms, the number of each of these atoms, or the connectivity between these atoms differ between two chemical compounds, for instance cocaine versus methamphetamine, the vibrational frequencies or Raman spectra, will be different. Raman spectroscopy exploits this difference in each compound's vibrational frequencies to differentiate compounds (see Figure 1).

C.V. Raman discovered Raman spectroscopy in the 1920s and he later received the Nobel Prize in Physics for his discovery. The past four decades have seen a renaissance in the technique due to the development of stable lasers, miniaturized components, and fast computers with associated "search/match" algorithms. As such, Raman spectroscopy is a generally accepted scientific technique and is recommended for use by the US Food and Drug Administration (FDA) and the United States Pharmacopeia (USP) for the chemical identification of ethical pharmaceuticals. Accordingly, the use of Raman spectroscopy to identify narcotics is well within the capability of the technique and is well-suited for use by law enforcement.

## Field-Based Narcotics Identification

Handheld, field-based Raman instruments—or spectrometers as they are more precisely known—have been used extensively for on-scene identification of explosives and hazardous chemicals. Small, ruggedized equipment allows first responders to conduct a quick and safe initial assessment of potentially hazardous incidents.

More recently, Raman handheld systems are used for field-based narcotics identification. As noted, Raman spectroscopy is a well-established forensic laboratory technique. Further, it is also accepted by the Scientific Working Group for the Analysis of Seized Drugs (SWGDRUG) for the analysis of controlled substances. Forensic labs tasked with providing confirmatory narcotic testing results will also frequently use gas chromatography/mass spectrometry (GC/MS), which some consider the gold standard in analytical instrumentation. Although GC/MS provides definitive results, it is a costly, laboratory-based technique, which is time-consuming and contributes to the backlog of samples, subsequently delaying the reporting of results back to law enforcement agencies waiting to prosecute cases.

## Raman Spectroscopy, A Proven Technique

Raman spectroscopy already has a proven track record in U.S. Federal District Courts. A number of civil actions, specifically intellectual property cases involving patent litigation in the pharmaceutical arena (Takeda v Teva, US District Court, Dist. of Delaware, Civ. No. 06-033-SLR; Abraxis Bioscience v Navinta, US District Court, Dist. of New Jersey, Civ. No. 07-1251 (JAP); Abbott/FournierIndustrie v Teva, US District Court, Dist. of Delaware, Civ. No. 02-1512-KAJ), have used and relied on Raman spectroscopy. Raman spectroscopy for the chemical identification of narcotic (or controlled) substances meets the Daubert admissibility standards, namely:

1) Raman spectroscopy is a well-understood technique in which multiple uses in numerous fields (chemical, polymer, biological, pharmaceutical, materials science) have been published in thousands of peer-reviewed journals, books, treatises, and book chapters;

2) The theory of Raman is well understood and the discoverer of the technique has won a Nobel Prize for his discovery and explanation of the theory;

3) The scientific community has established standards that can assess the accuracy and precision of the technique. These standards are available to the scientific community from nationally recognized standard setting organizations;

4) Raman has been tested not only in the laboratory, but also in field settings; the specific use in the context of narcotics testing;

5) The relevance and reliability of the technique has been tested and reported by the scientific community;

6) Finally, the technique of Raman spectroscopy is of general acceptance by the scientific community, in fact, authorized for use by the US FDA and USP.

### Thermo Scientific TruNarc Analyzers: Potential Impact on Prosecution

The Thermo Scientific™ TruNarc™ analyzer is a handheld, field-based narcotics identification system that rapidly identifies numerous narcotics in seconds with a single test. Leveraging Raman spectroscopy, the TruNarc analyzer brings together the high chemical specificity of Raman with non-destructive and non-contact analysis. These features minimize exposure of the unknown materials to law enforcement officers and maintain the original state of the evidence. Most narcotic samples can be quickly identified in their original packaging by simply pressing the sample, contained in a plastic bag, for example, against the nosecone of the analyzer and pressing the scan button.

The TruNarc analyzer provides a clear, definitive result, with no user interpretation required. All scans are time and date stamped and stored automatically in the analyzer. The intuitive user interface allows the law enforcement officer to easily transfer the data from the handheld unit to a computer for automated storage and reporting. The analyzer includes a diagnostic system self-check to verify the instrument is working properly at the time of use and can support chain of custody for prosecution with permanent, printable records.

### Consideration of the Melendez-Diaz Case

Within the United States court system, attorneys representing defendants in narcotics cases are allowed to subpoena any scientists that present laboratory test results on suspect narcotics samples submitted into evidence— a consequence of the 2009 United States Supreme Court ruling on *Luis E. Melendez-Diaz v. Massachusetts*.

This pivotal decision resulted from a 2001 cocaine trafficking case involving Luis Melendez-Diaz. The local court ruled that Melendez-Diaz' 6th Amendment rights were violated—his right to confront his accuser—when the lab technician who performed the testing on the "white powder" identified as cocaine, did not testify in person. During the original trial, the defense attorney objected to the laboratory certification evidence based on the 6th Amendment, but the court over-ruled the objection.

Melendez-Diaz was found guilty, appealed, lost, and was eventually convicted. Later, Melendez-Diaz appealed his case to the U.S. Supreme Court, which in 2009 reversed the Massachusetts appellate court ruling, and new precedent was set. Defense attorneys are now allowed to request testimony from the scientist who completes narcotics testing used as evidence for prosecution. This ruling has a tremendous impact on the competing tasks of the scientists: timely analysis of sample submissions versus court room testimony.

Due to these new burdens on lab technicians and the prosecution, shifting a portion of narcotics identification work from the laboratory to the field could reduce sample backlogs and yield a faster and more streamlined prosecution process for all narcotics cases.

### A comparison of Thermo Scientific TruNarc and Lab Results

A study was conducted comparing street samples of cocaine, heroin, and methamphetamine analyzed by the TruNarc system with laboratory test results for the same drug samples. The study found that 131 of the 137 street samples measured with the TruNarc analyzer agreed with the lab result. The remaining results provided valuable information to inform subsequent analyses, including correct identification of the cutting agent. There were no false positive results. For more information, refer to "Improvements in Field Narcotics Identification Using Raman Spectroscopy: A Comparison of Raman Field Test Results and Laboratory Test Results," White Paper 201b.

### Conclusion

While there is variation from state to state and country to country, the current process of adjudicating drug-related arrests is similar. After presumptive testing, samples of seized drugs are typically sent to a laboratory for analysis. Despite an increase in drug trafficking, cost-cutting pressures are forcing jurisdictions to evaluate how many drug cases they prosecute and whether or not these drugs are sent to the lab for analysis.

In the 1970s, there was a significant movement to reduce the number of lab tests for DUI arrests. This resulted in the acceptance of field confirmatory breathalyzer/ blood alcohol content testing for DUI arrests; narcotics testing is following a similar path. Additionally, the added time-burden of defense attorneys having the ability to require chemists to testify in court as a result of the Melendez-Diaz ruling has had a significant and costly impact on the judicial process of prosecuting a drug user or drug dealer. Finding a way to relieve this pressure could directly impact the high costs associated with laboratory drug testing.

In addition to reducing laboratory backlogs, there are other significant opportunities where using the TruNarc analyzer could ease the costly burden of narcotics analysis on law enforcement agencies. First, it can be used as a screening tool for multiple sample submissions to a laboratory. In this scenario, laboratories could sample a smaller set of submissions for confirmatory testing. Second, it could be leveraged for field confirmatory identification for possession cases, thereby allowing laboratories to focus on trafficking cases and samples that fall outside the capabilities of field instrumentation.

The TruNarc analyzer is an easy-to-use system which provides clear, definitive results, and automatic, comprehensive reports for every analysis. In addition to self-check results and time and date stamp, the analyzer collects detailed spectral data, which can be further analyzed and compared to library standards if needed for prosecution. With the Thermo Scientific TruNarc analyzer, law enforcement officers can now identify suspected narcotics and controlled substances at the point of seizure—with a reliable, court- and lab-proven technology.

## About the Authors


### David E. Bugay, Ph.D.

David E. Bugay has more than 23 years of experience in the pharmaceutical industry and has recently established his own consulting company (PharmAnalysis, 2008) and partnership in a research laboratory (Triclinic Labs, 2009). In 2003, Dr. Bugay was recognized as a Fellow of AAPS and served on the 2005-2010 USP General Chapters Expert Committee as well as the USP NMR Advisory Panel. Dr. Bugay has lectured worldwide and taught numerous courses focused on pharmaceutical solids and advanced analytical technologies, including training for the U.S. Patent and Trademark Office as well as the European Patent Office. Dr. Bugay further serves as an expert witness for pharmaceutical patent litigation cases in numerous domestic and international jurisdictions.

### Michael Cipoletti, M.S.

Currently an assistant professor and the program director of forensic science at Waynesburg University, Mike Cipoletti is an associate member of the American Academy of Forensic Science and a member of the Mid-Atlantic Association of Forensic Scientists. Previously he served the Pennsylvania State Police (PSP) Crime Laboratory as a forensic scientist and the system's drug identification technical leader. In those capacities, Mr. Cipoletti analyzed thousands of cases, trained numerous drug analysts, and developed and reviewed quality assurance policies for the drug identification sections. Cipoletti also served as a member of PSP's certified clandestine laboratory response team and was responsible for assisting in the investigation and processing of illicit drug labs and hazardous materials. He has been qualified on numerous occasions to testify as an expert in Pennsylvania and the federal court systems.


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