

# **New Tools for the Law Enforcement Community**

**Keiji Asano**

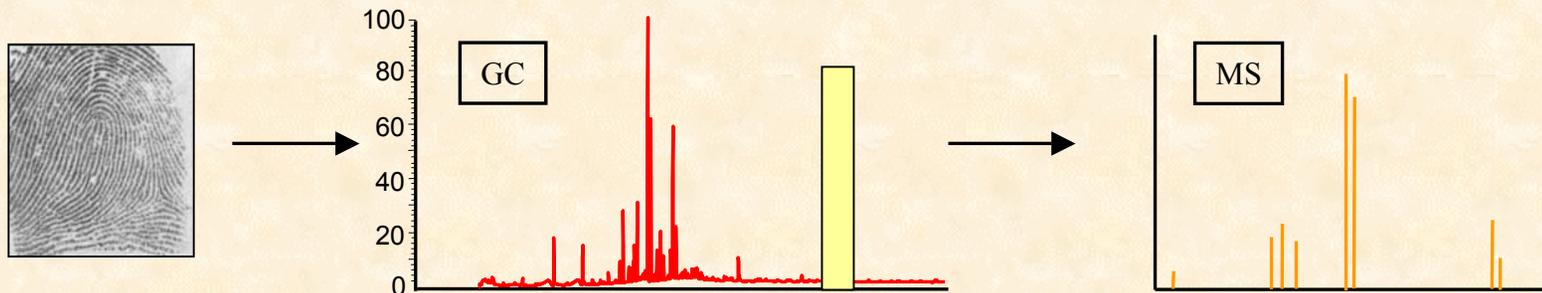
**Organic and Biological Mass Spectrometry  
Oak Ridge National Laboratory**

**Innovative Technologies for Community  
Corrections Conference  
May 20-22, 2002**

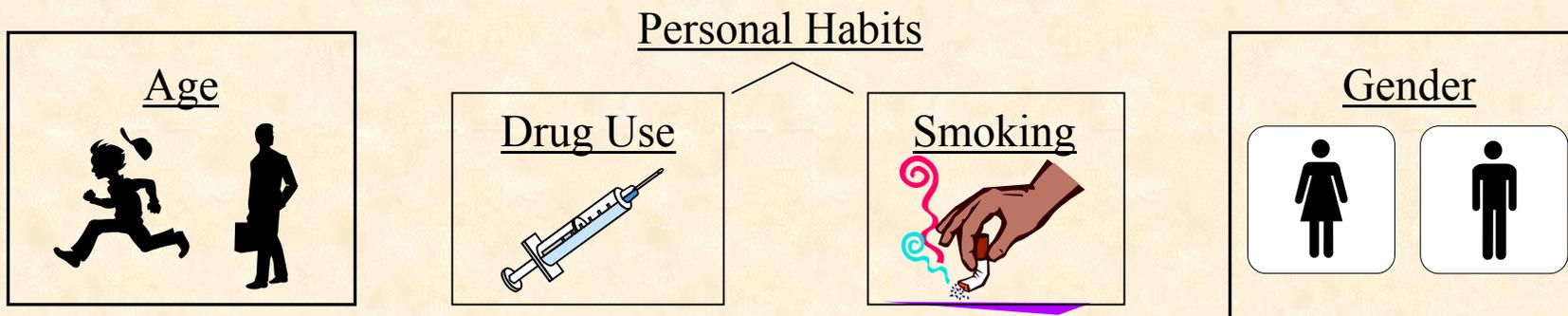
# TOPICS

- **Non-invasive sampling for drug screening**
  - **Fingerprint Component Analysis**
- **Rapid and sensitive detection of targeted species**
  - **Thermal Desorption Tandem Mass Spectrometry**

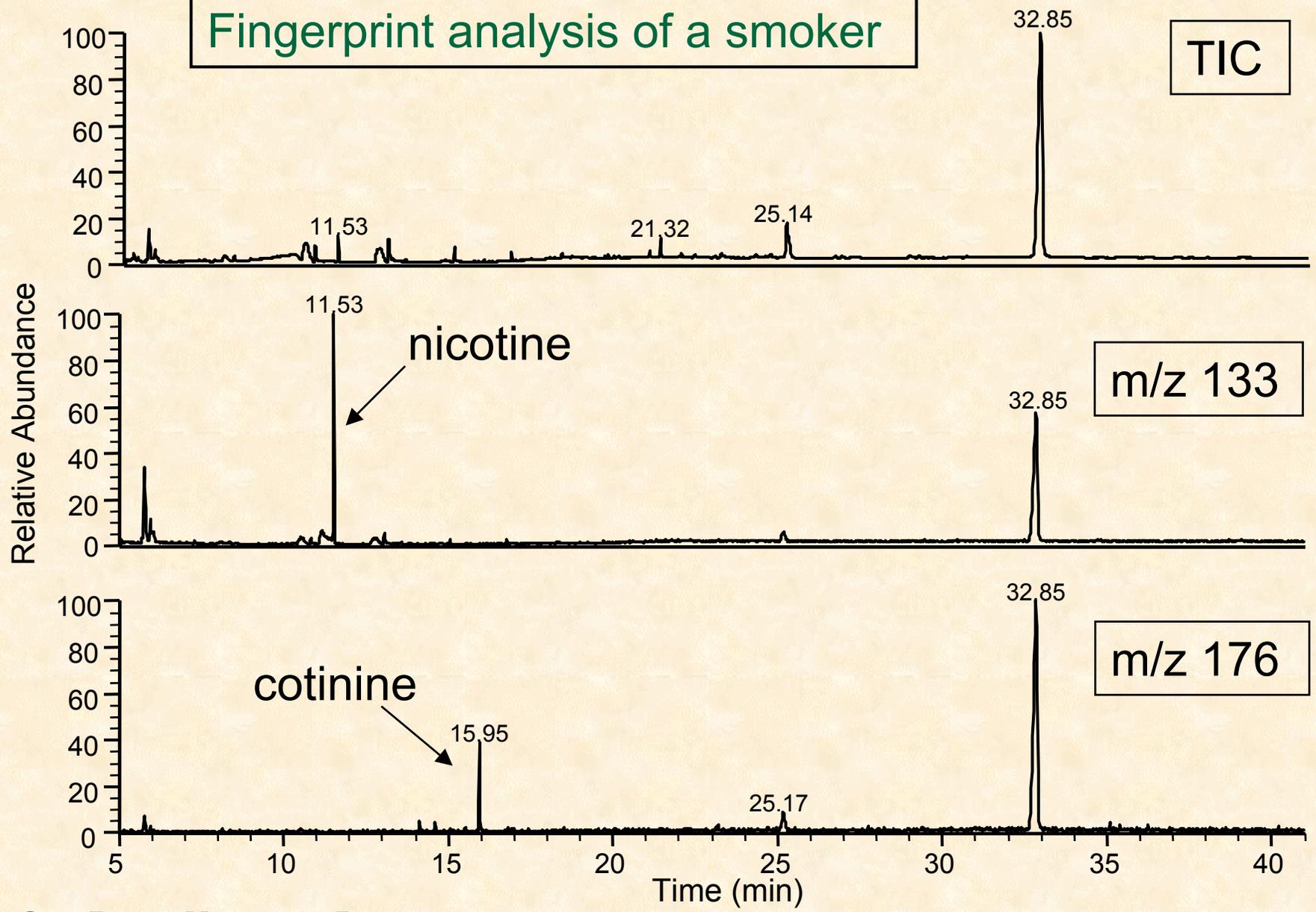
# Fingerprint Component Analysis Overview



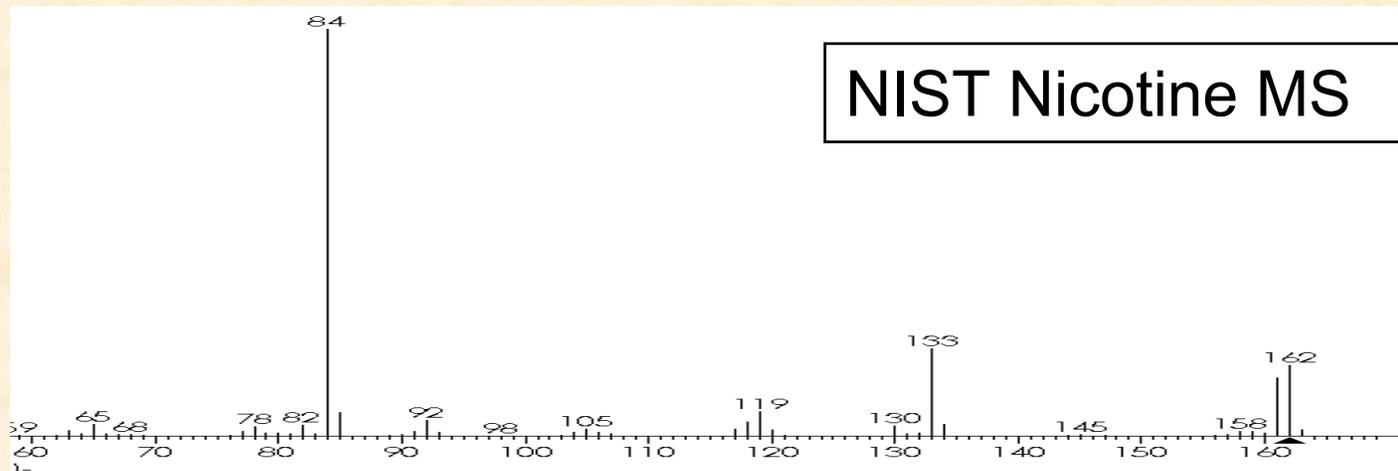
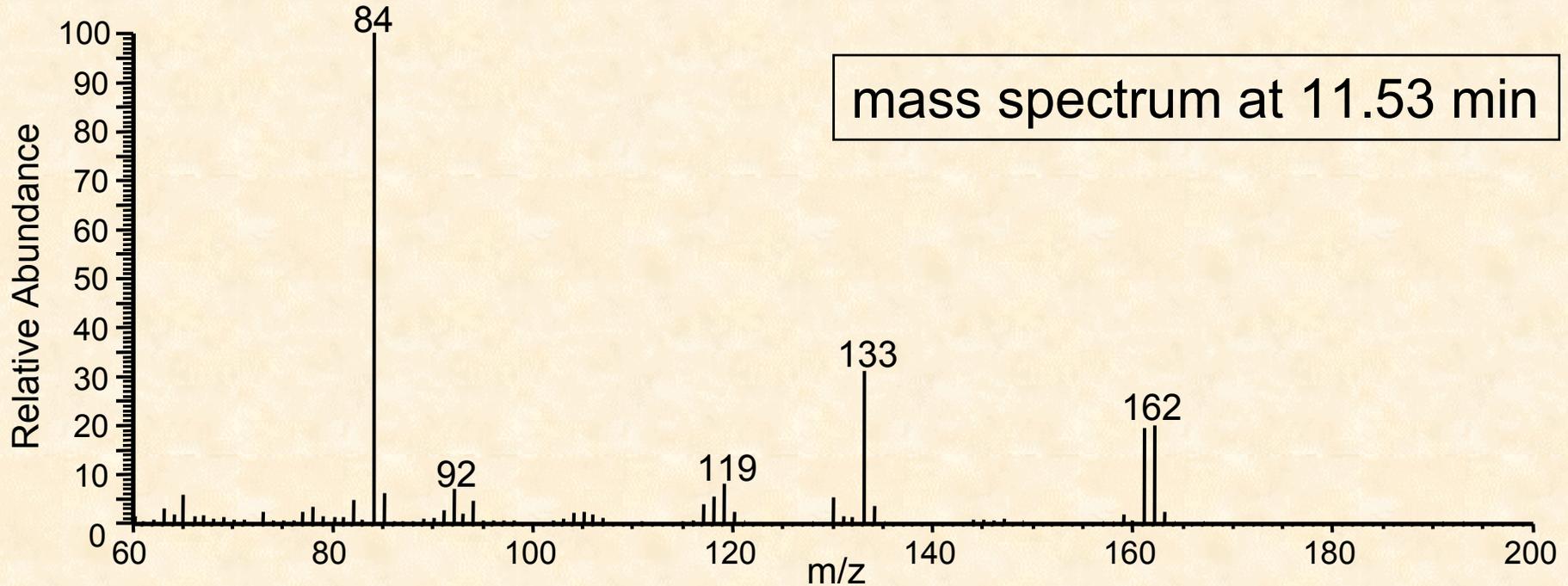
Components from an individual's fingerprint ridges can be identified using gas chromatography/mass spectrometry. This information might be useful in characterizing people based on age, personal habits, or gender when an identification cannot be made from the fingerprint pattern itself. Analyzing fingerprint residue can also be used as a drug screening tool.



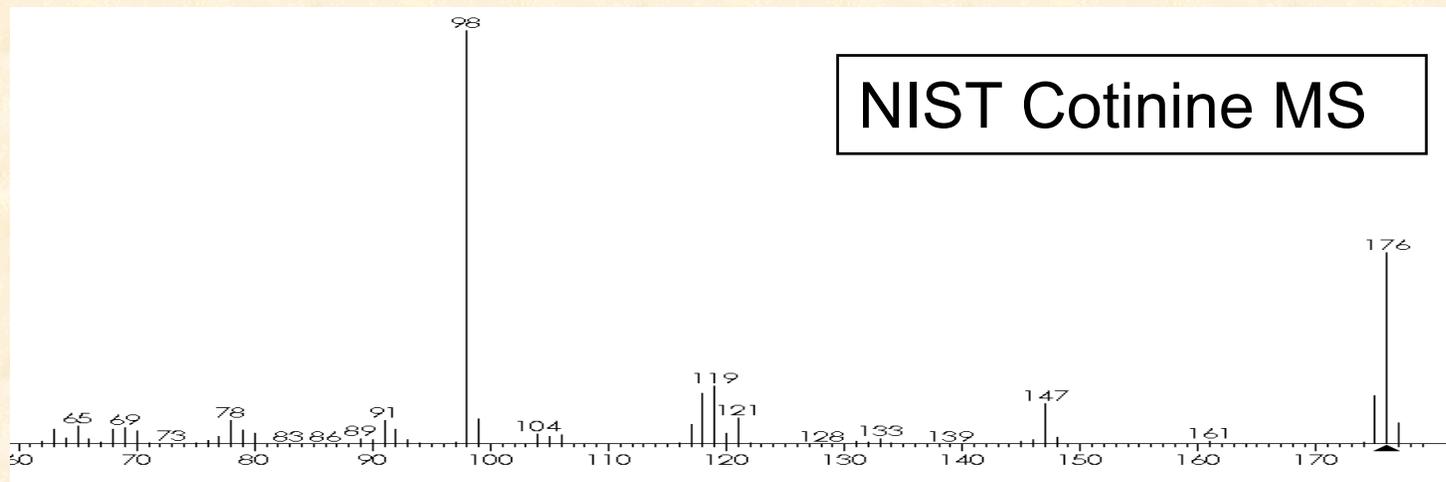
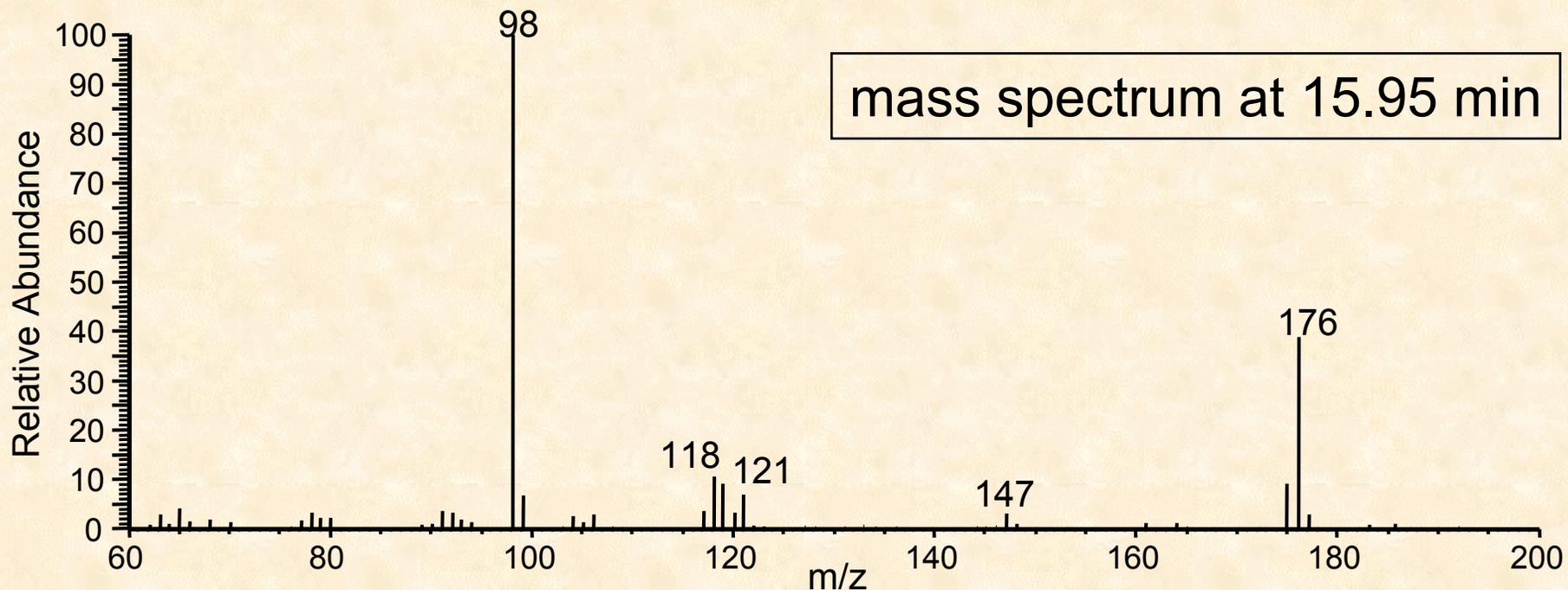
# Fingerprint analysis of a smoker



# Confirmation of Nicotine



# Confirmation of Cotinine



# Objectives for Drug Study

- Can we detect drugs in fingerprint residue?
- Can we differentiate between use and exposure?
- Can we correlate with urinalysis to determine cutoff levels?

# Davidson County Community Corrections, Nashville, TN

- **623 People**
  - 348 inactive
  - 275 active
- **Active people report weekly**
- **Tested every other month, minimum**

# Protocol

- **Court officers trained on sample collection using glass beads**
- **Subjects must read and sign consent form before participating**
- **After providing fingertip residue sample, volunteers provide urine sample per normal SOP**
- **Urine and fingertip samples from each volunteer coded with unique identifier**
- **Samples shipped overnight to ORNL in cooler with ice packs**
- **Samples were given new identifying code at ORNL**
- **Samples stored in freezer until processed**

**INFORMED CONSENT FOR PARTICIPATION IN RESEARCH ACTIVITIES**

**Volunteer's Authorization**

Volunteer: \_\_\_\_\_

Principal Investigator: Michelle V. Buchanan, Oak Ridge National Laboratory, PO Box 2008 Oak Ridge, TN, 37831-6124, Phone: (865)-574-4521

Project Title: Characterization of Components in Fingertips, Subtask 1: Amendment (c)Volunteers from Drug Rehabilitation Programs, sponsored by the Department of Energy

This consent form may contain words that you do not understand. Please ask the study staff to explain any words or information that you do not clearly understand.

**1. You are invited to participate in a research study conducted by Dr. Michelle Buchanan and/or associates at the Oak Ridge National Laboratory (ORNL).**

The overall purpose of this research is to look for chemical compounds, including drugs (such as cocaine, marijuana, heroin) and their break-down products, present in skin. Chemical compounds found on skin can come from things you touch or in your sweat from things in your body. If our studies are successful, it may be possible to know whether an individual is a male or female, a smoker, a drug user, and their approximate age, just by looking at the chemicals present on a person's fingertips.

2. Your participation in this research study will involve providing a sample from your skin by rubbing a glass bead between your fingertips. You may be asked to wipe your forehead with your fingertips before doing this. Collection of this sample will take less than five minutes and will be done at the same time as collection of a urine sample for required drug testing. No record of your fingerprint is made when you rub the glass bead. The fingertip samples will be analyzed at ORNL. Unused portions of the sample you provide will be destroyed immediately after the sample is analyzed. No samples or portions of samples will be kept. The results from your urine sample for the mandatory drug testing will be sent to ORNL coded with the sample code of the fingertip smear to compare results. Your name will not be on the sample results given to the ORNL researchers.

**3. There are no known physical risks and/or discomforts that may be associated with this research.**

**4. The possible benefits to you and society from this research are:**

Your participation will be of no immediate benefit to you, but may help you and others in the future by leading to a new method for drug testing, and/or medical diagnostics.

**5. Your participation in this study is entirely voluntary. You may choose not to participate or having agreed to participate, you may withdraw from the study at any time without penalty or loss of benefits to which you may be entitled.**

**6. Protection of Confidentiality:**

Your identity will be protected in this study because neither the samples on the glass beads nor the urine test results will have your name associated with them. The glass bead sample and the urine test results will be labeled only with a code number. Researchers at ORNL will have no way of linking your sample or the urine test results to your name. There will be no way for the information in this informed consent form or the results of the studies of the samples you provide to be associated with you or your sample(s).

We will not give anyone the results of our test of individual samples. The results of this research may be presented at scientific meetings or reported in scientific or other official reports, but you will never be

I (volunteer's name, print clearly or type), \_\_\_\_\_, have read the information on the research project, Characterization of Components on Fingertips, and voluntarily agree to participate in this research study. I have been told that I will be given a copy of this signed consent form

Signature \_\_\_\_\_ Date and Time \_\_\_\_\_

I (person obtaining consent, print or type name) \_\_\_\_\_, verify having discussed with (volunteer's name, print or type) \_\_\_\_\_ the subject of the study objectives, methods, associated risks, and benefits of this research.

Signature \_\_\_\_\_ Date and Time \_\_\_\_\_

Affiliation \_\_\_\_\_

Witnessed By

Name (printed/typed) \_\_\_\_\_

Signature \_\_\_\_\_ Date and Time \_\_\_\_\_

If you have any questions about this research study or your rights and responsibilities as a participant, please contact Dr. Buchanan or the Chairperson of the ORAU/ORNL Institutional Review Board at (865)-576-1725.

Protocol approved by the ORAU/ORNL Committee on Human Studies (IRB #M1394) on 7/28/94; reviewed and approved for continuation with revised consent form for 6 months from June 1, xxxx through November 30, xxxx

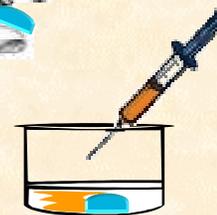
# EXPERIMENTAL

- **Sampling and Sample Preparation**

- Rub glass bead between fingertips



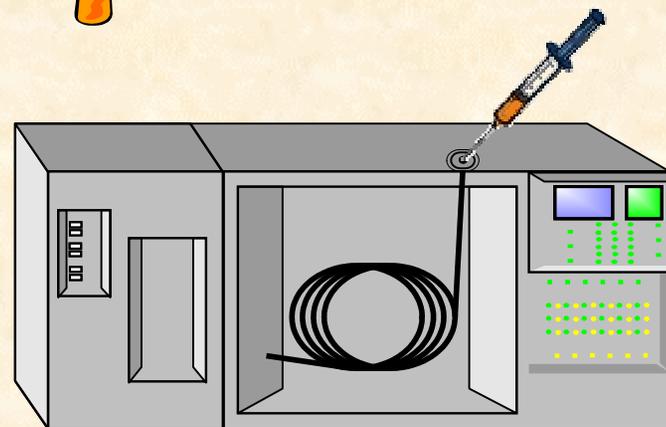
- Extract Residue on bead with organic solvent



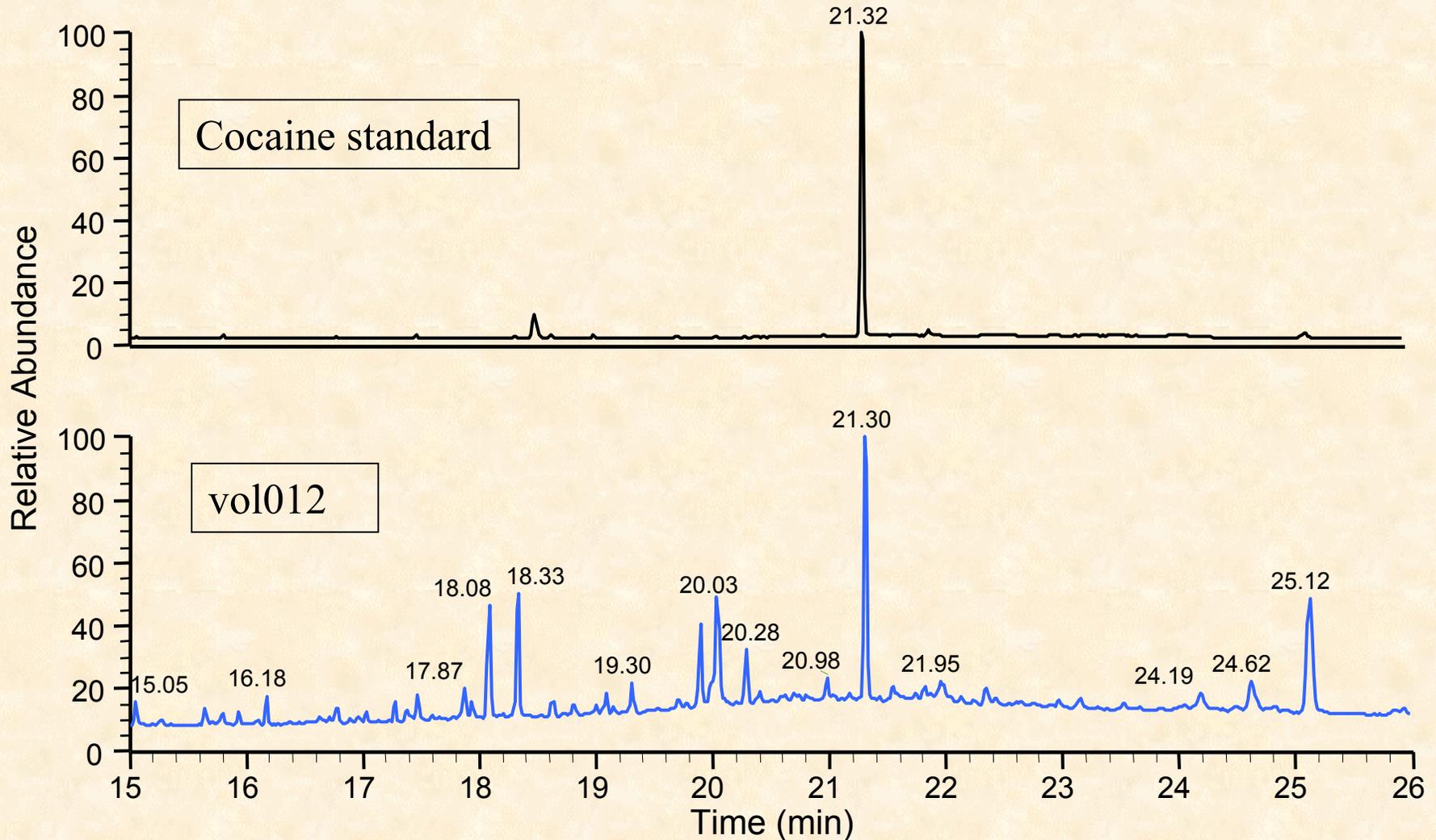
- Evaporate and reconstitute



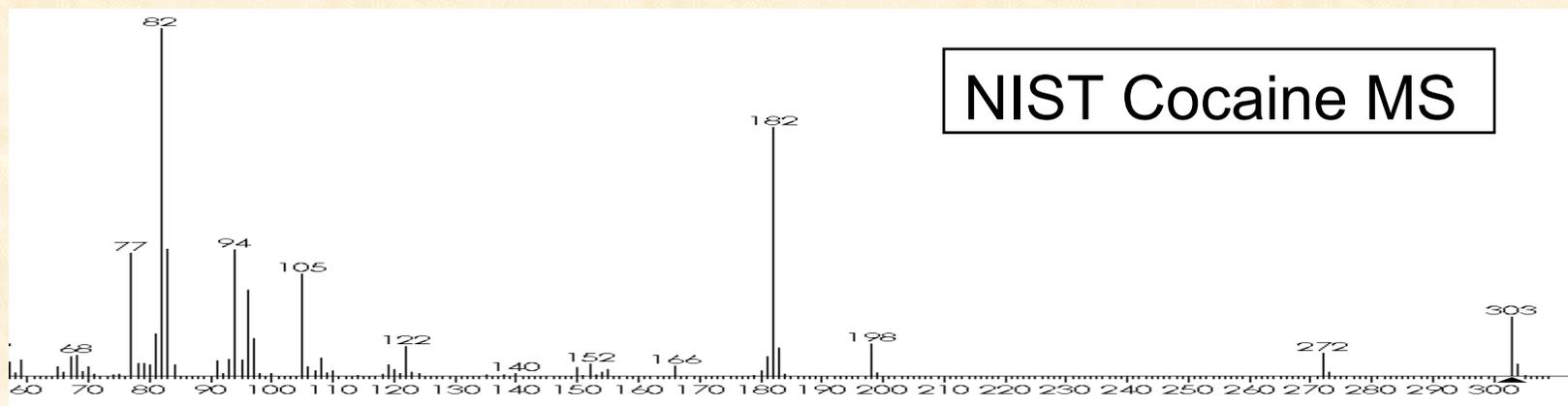
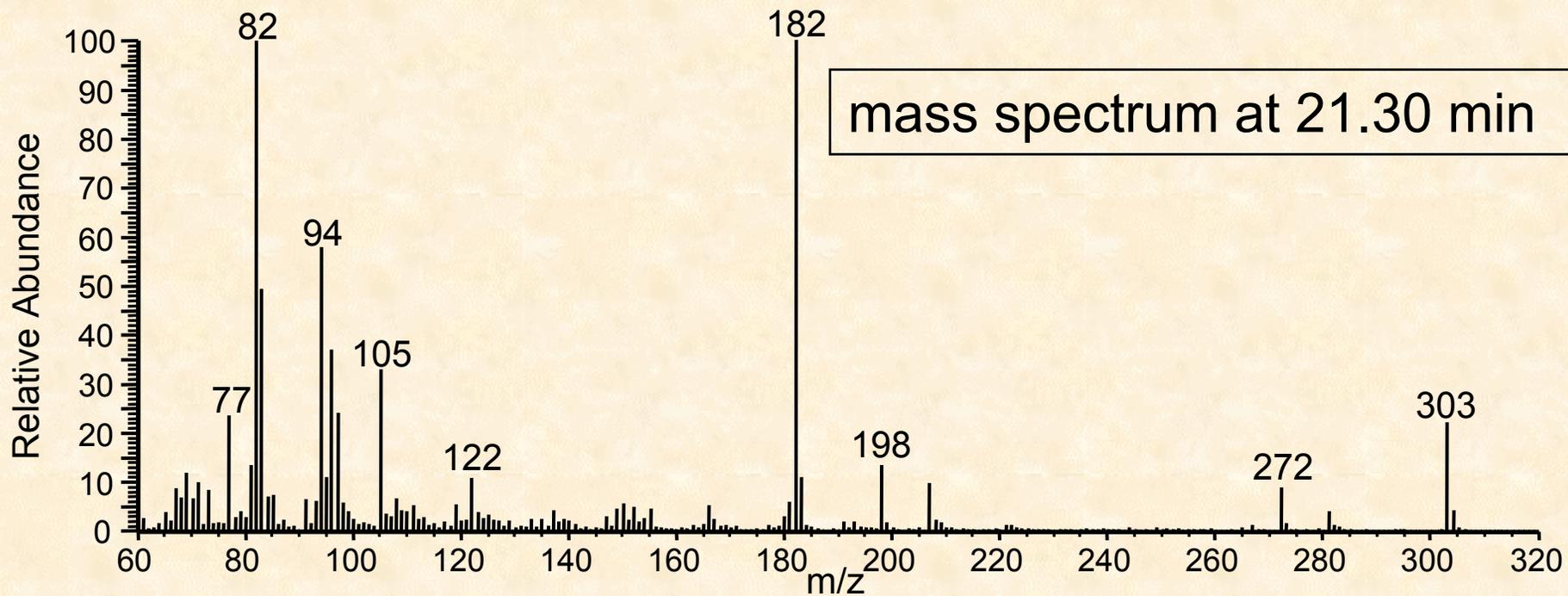
- Derivatize or inject directly into GC column



# Evidence of Cocaine in Volunteer's Fingerprint Residue



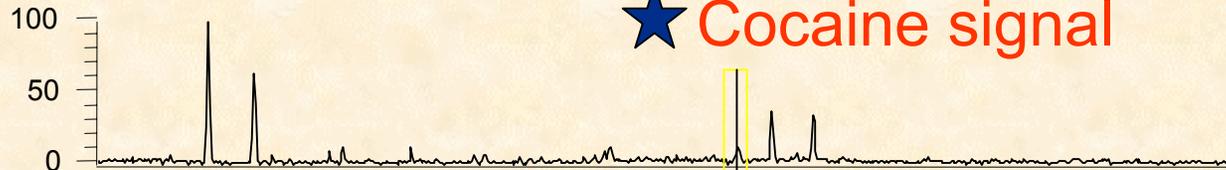
# Confirmation of Cocaine



RT: 15.00 - 30.00

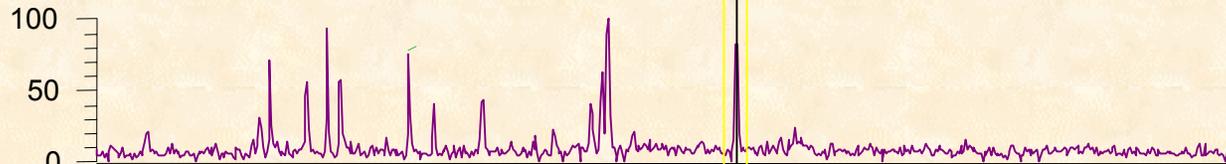
★ Cocaine signal

Relative Abundance



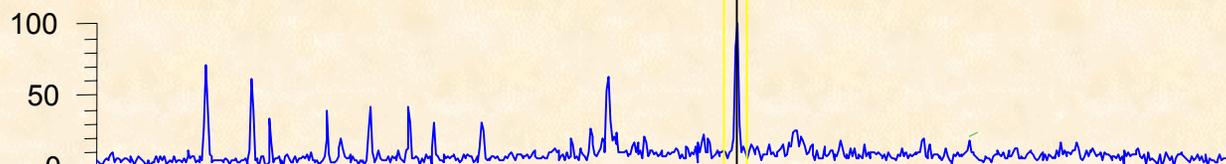
Vol1001  
(-)

NL:  
2.87E4  
m/z=  
181.5-182.5



Vol1002  
(+)

NL:  
9.12E3  
m/z=  
181.5-182.5



Vol1003  
(-)

NL:  
1.04E4  
m/z=  
181.5-182.5



Vol1004  
(+)

NL:  
1.88E5  
m/z=  
181.5-182.5



Vol1005  
(-)

NL:  
2.15E4  
m/z=  
181.5-182.5



Vol1006  
(-)

NL:  
5.90E3  
m/z=  
181.5-182.5

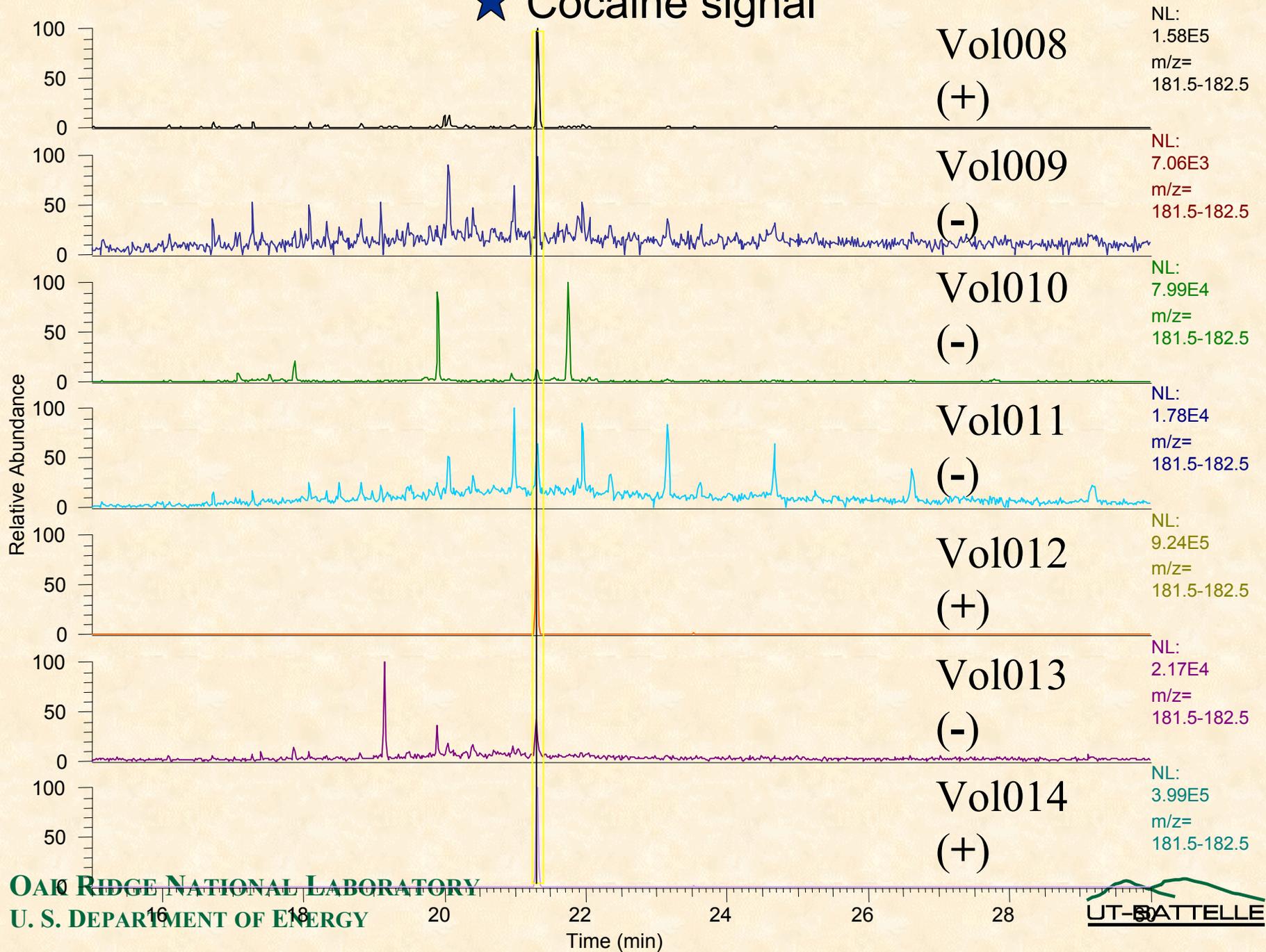


Vol1007  
(+)

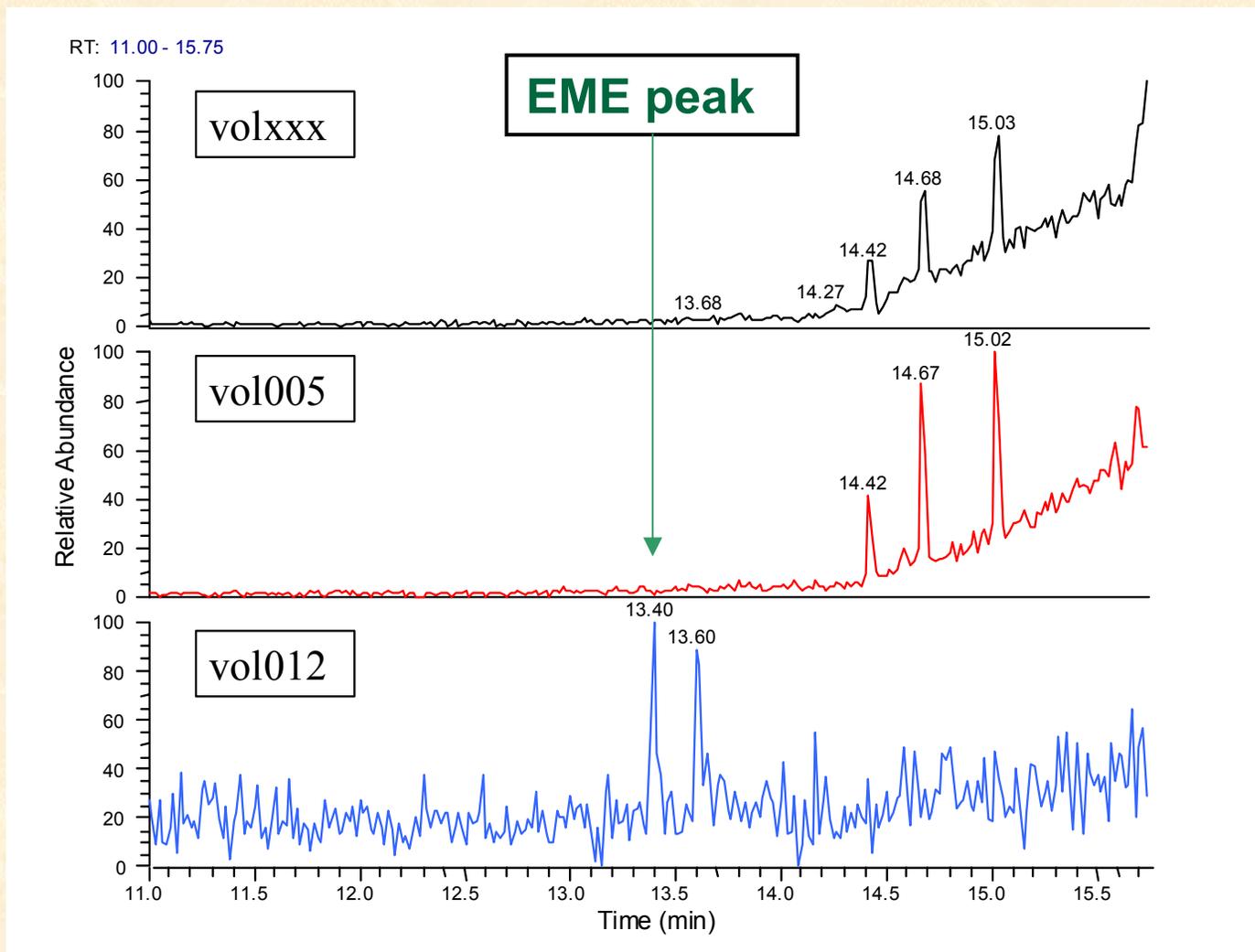
NL:  
2.26E4  
m/z=  
181.5-182.5

RT: 15.00 - 30.00

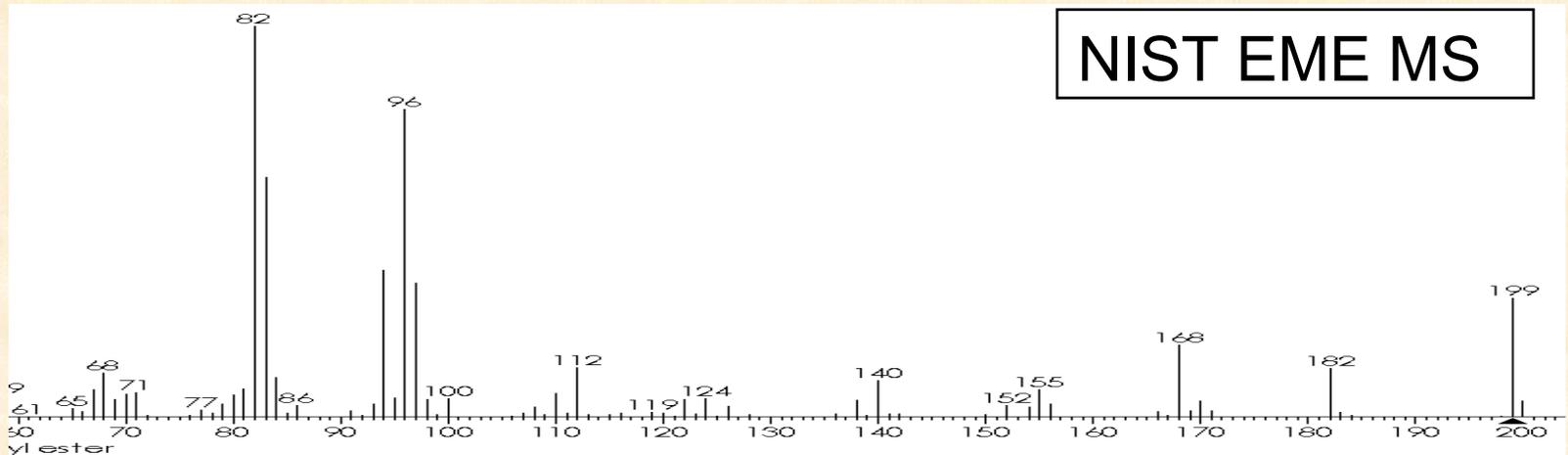
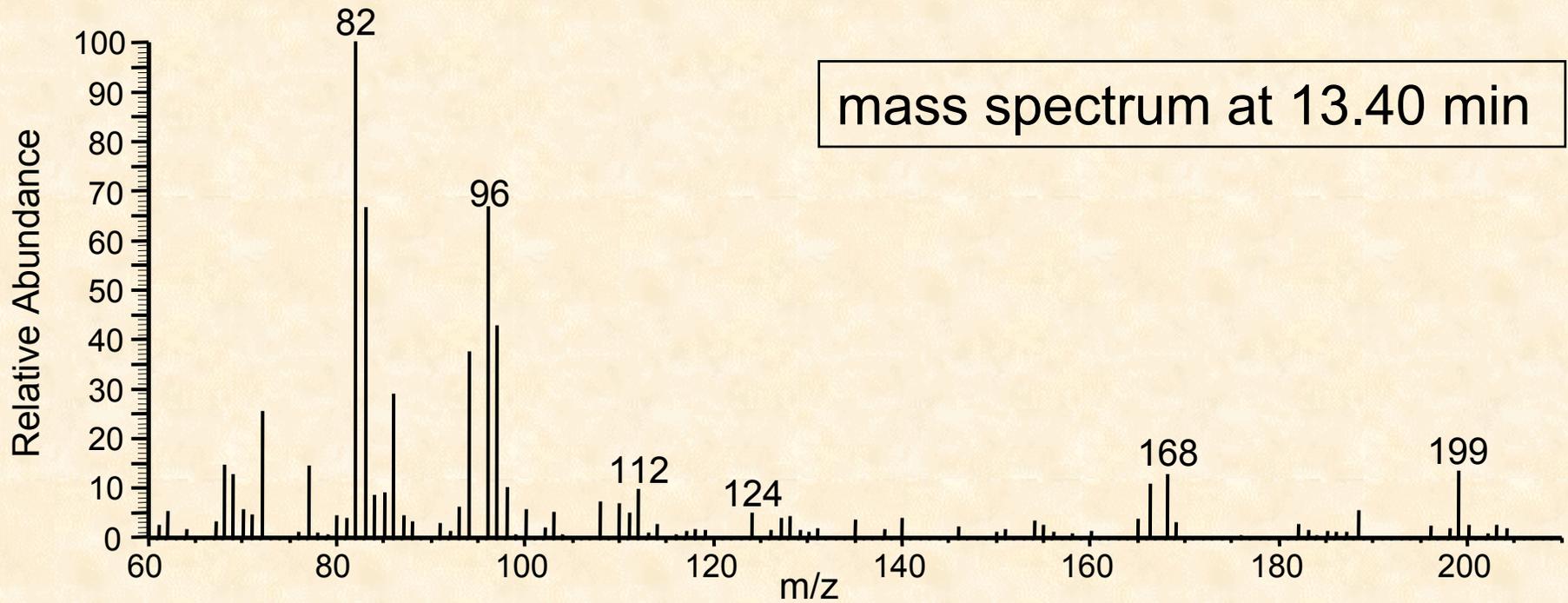
# ★ Cocaine signal



# Observance of Ecgonine Methyl Ester (EME), Cocaine Metabolite



# Confirmation of EME



# Fingertip Residue Analysis

Subject	Cocaine	EME	Urinalysis	est. cocaine extracted pg/ $\mu$ L
vol001	no	no	no	-
vol002	yes	no	no	55
vol003	no	no	no	-
vol004	yes	no	no	575
vol005	no	no	no	-
vol006	no	no	no	-
vol007	yes	no	no	100
vol008	yes	?	no	470
vol009	no	no	no	-
vol010	no	no	no	-
vol011	no	no	no	-
vol012	yes	yes	yes	2825
vol013	no	no	no	-
vol014	yes	no	no	1300
vol015	no	no	no	-

Subject	Cocaine	EME	Urinalysis	est. cocaine extracted pg/ $\mu$ L
vol016-29	no	no	no	-
vol030	no	no	no	-
vol031	no	no	no	-
vol032	?	no	no	-
vol033	no	no	no	-
vol034	yes	no	no	108
vol035	yes	no	no	80
vol036	no	no	no	-
vol037	no	no	no	-
vol038	no	no	no	-
vol039	no	no	no	-
vol040	no	no	no	-
vol041	no	no	no	-
vol042	no	no	no	-
vol043	no	no	no	-
vol044	no	no	no	-

# Summary

- **Can we detect drugs in fingertip residue?**
  - **YES**
- **Can we differentiate between use and exposure?**
  - **Possibly**
- **Can we correlate with urinalysis to determine cutoff levels?**
  - **Unknown**

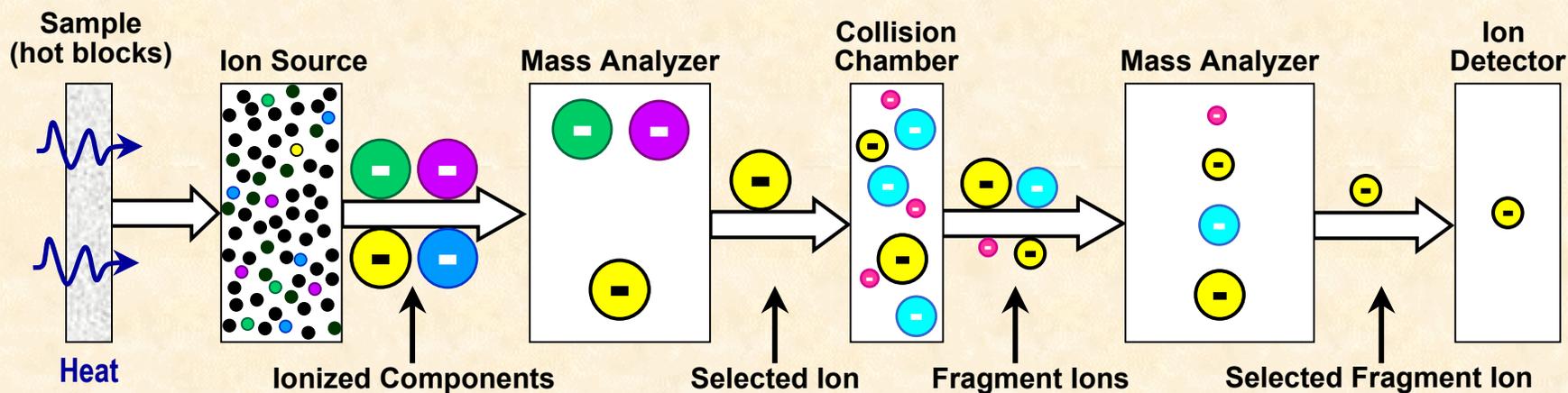
# Future Directions

- **Expand protocol to other drugs**
- **Establish a threshold that discriminates between positive and negative results**
- **Improve extraction efficiencies**
- **Investigate alternative technologies**

# TOPICS

- **Non-invasive sampling for drug screening**
  - **Fingerprint Component Analysis**
- **Rapid and sensitive detection of targeted species**
  - **Thermal Desorption Tandem Mass Spectrometry**

# Thermal Desorption, APCI Tandem Mass Spectrometry



 Targeted Molecule

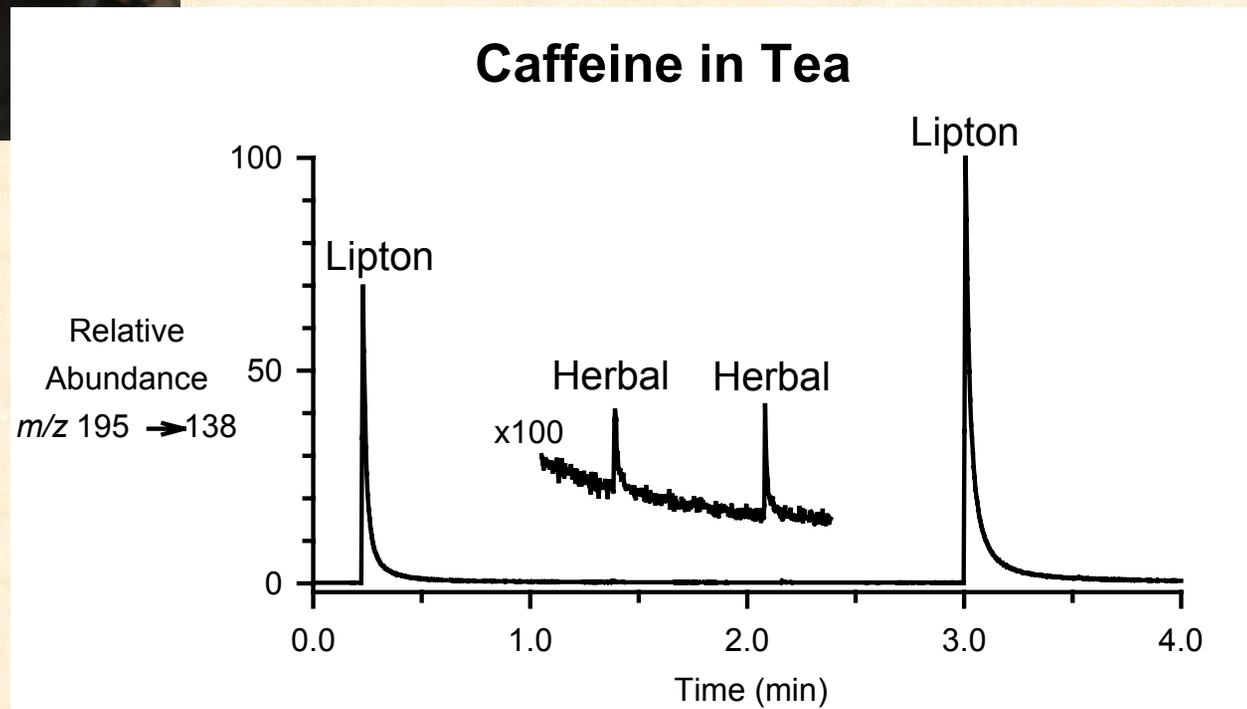
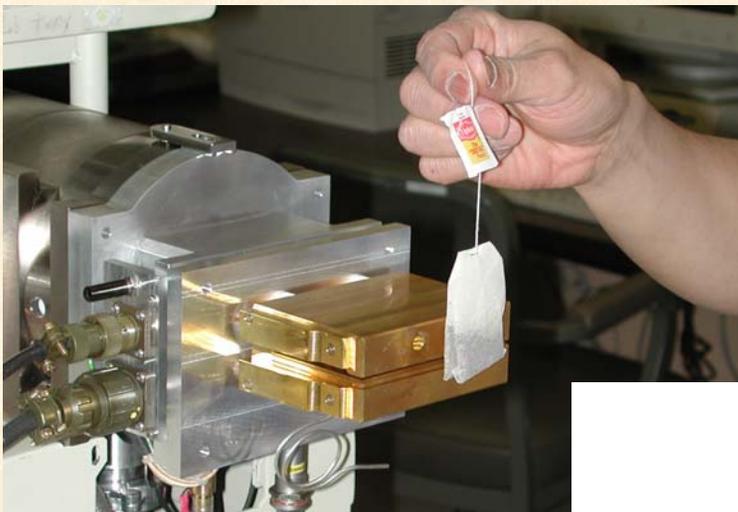
 Characteristic Fragment of Ionized Target Molecule

 Background Components

# System Characteristics

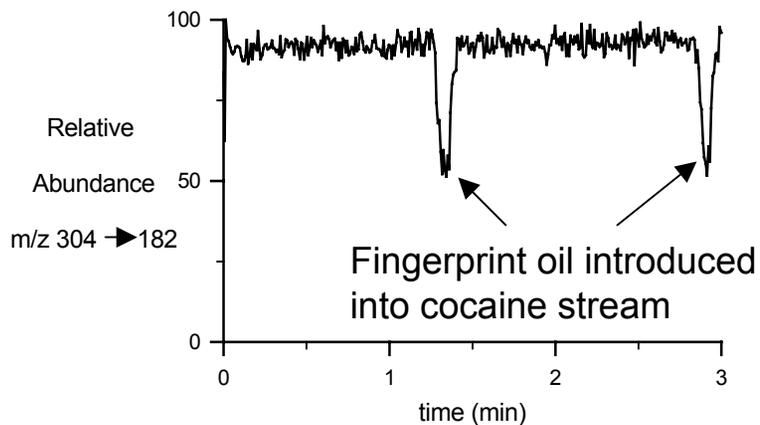
- **Rapid Response**
- **High Sensitivity**
- **High Specificity**

# Rapid Response and High Sensitivity

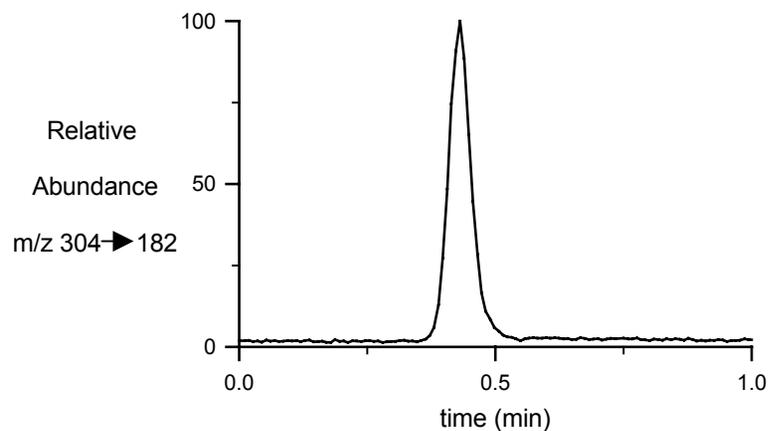


# Detecting Cocaine from Fingerprints using Thermal Desorption APCI

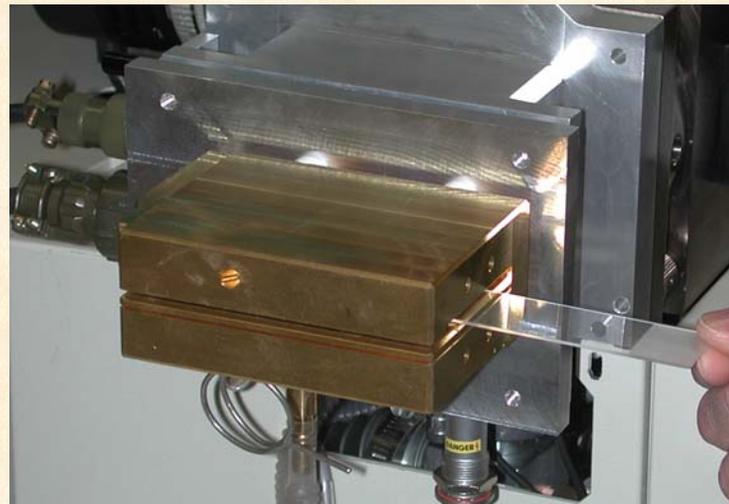
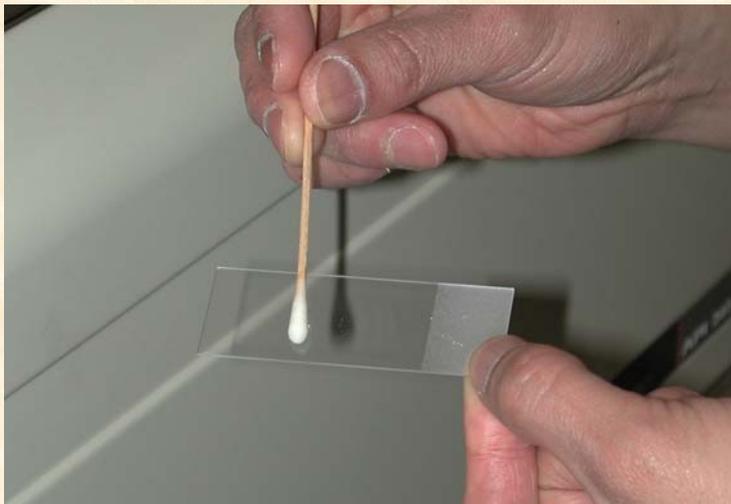
Effect of fingerprint oil on cocaine signal



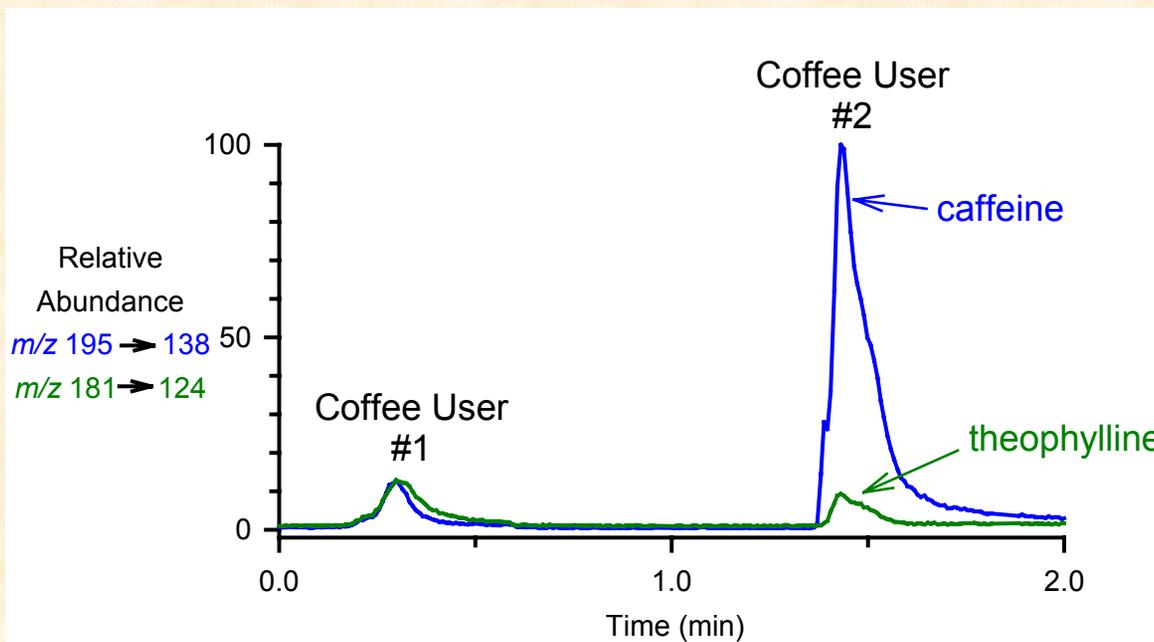
Cocaine from Fingerprint



# Fast Sampling and Processing

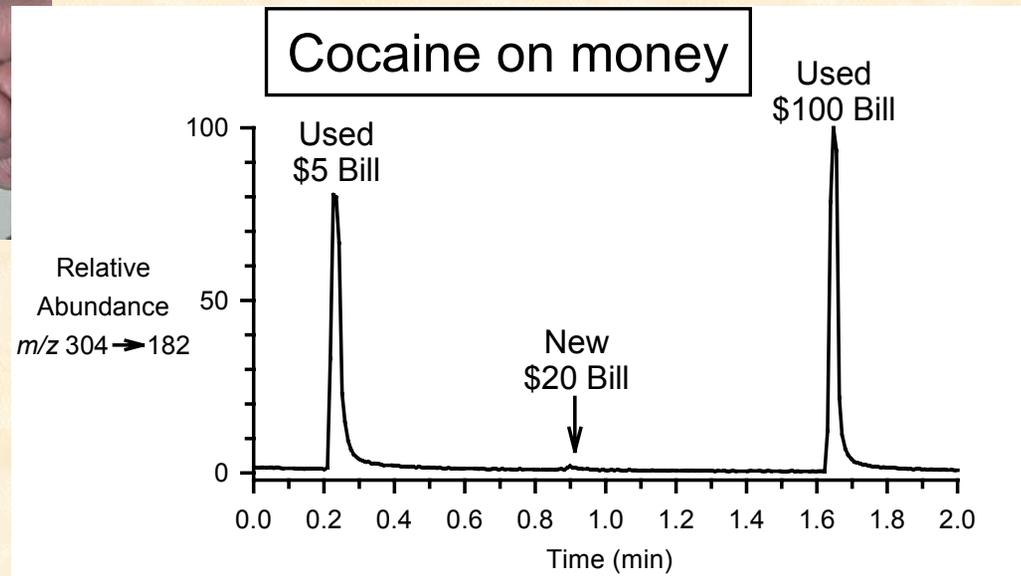


Saliva sampled from  
cheek (inside mouth)  
of coffee drinkers

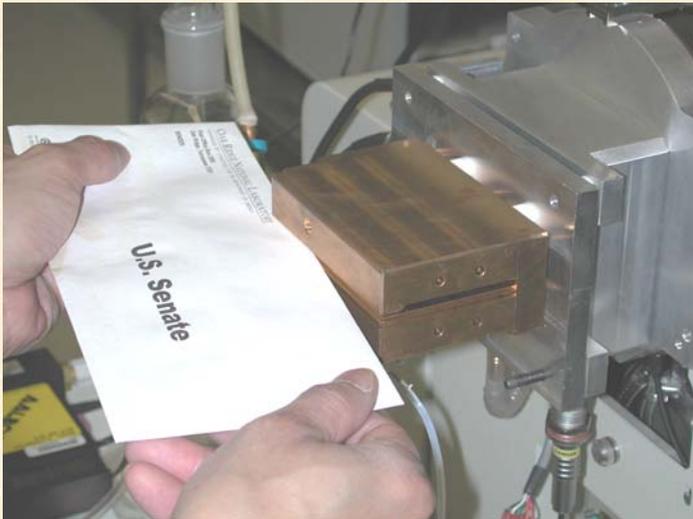


# Direct Sampling

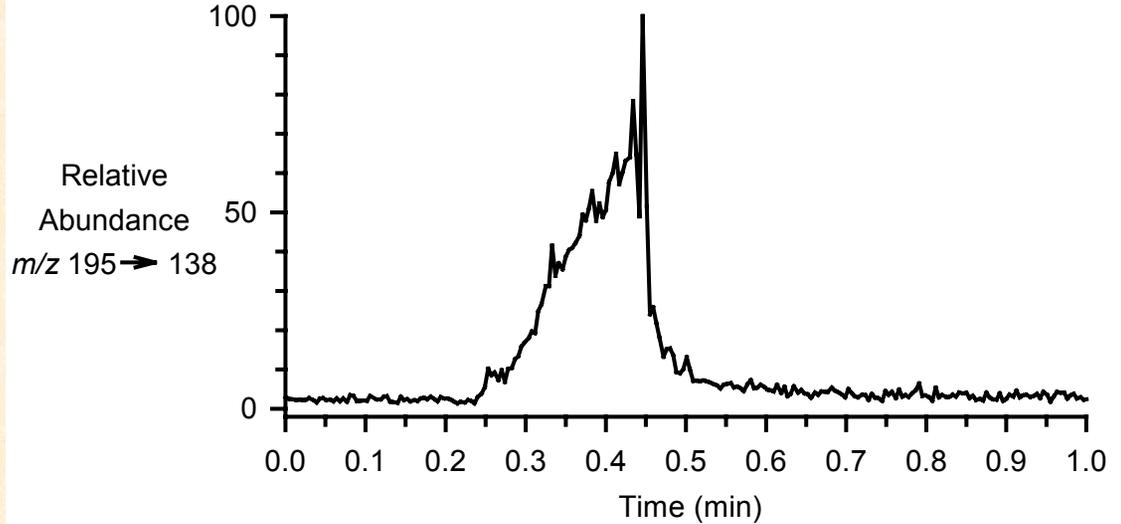
Is U.S. currency contaminated?



# Mail Screening



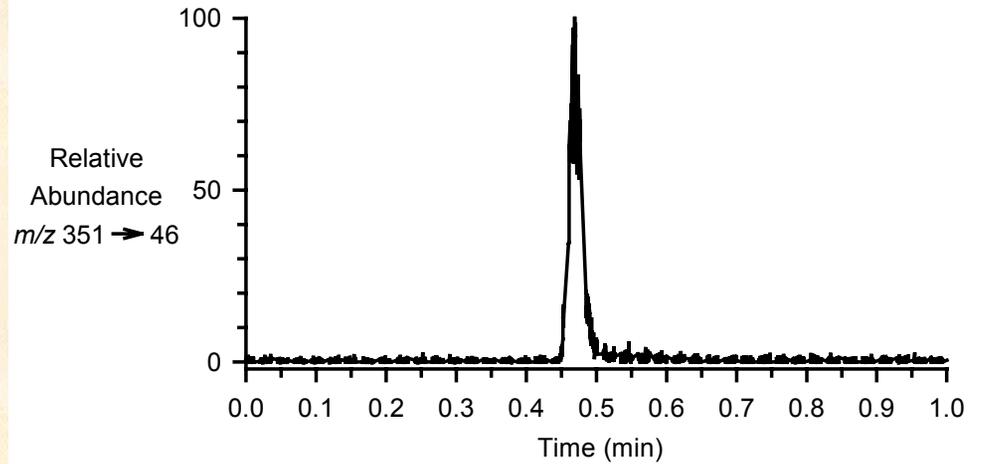
## Caffeine in Letter



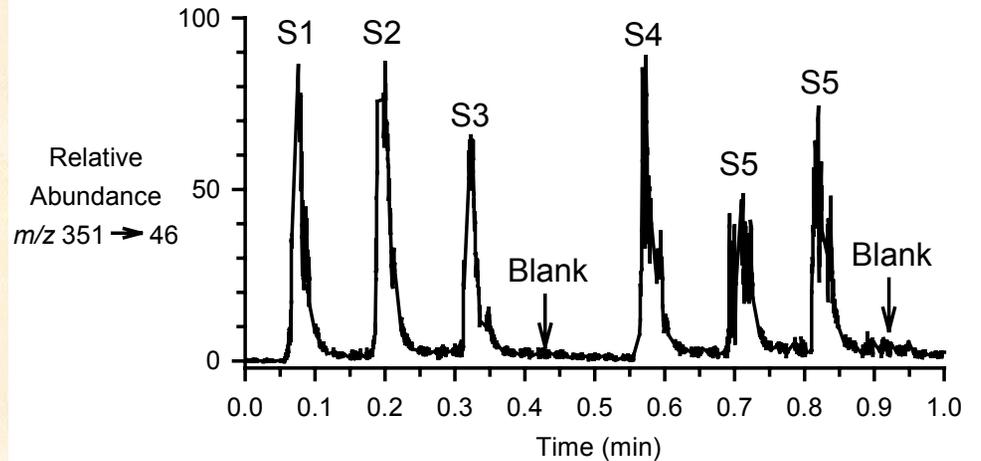
# Surface Analysis



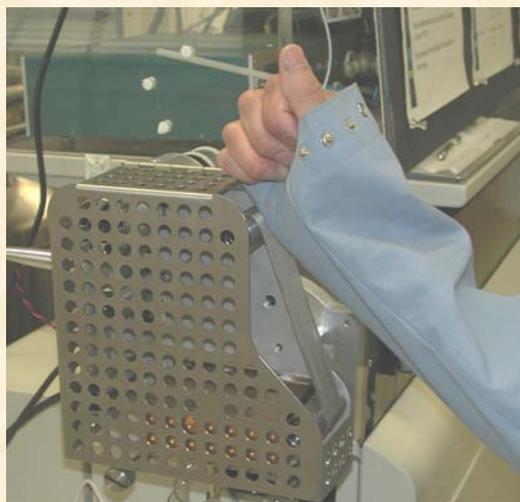
## Explosives Swipe



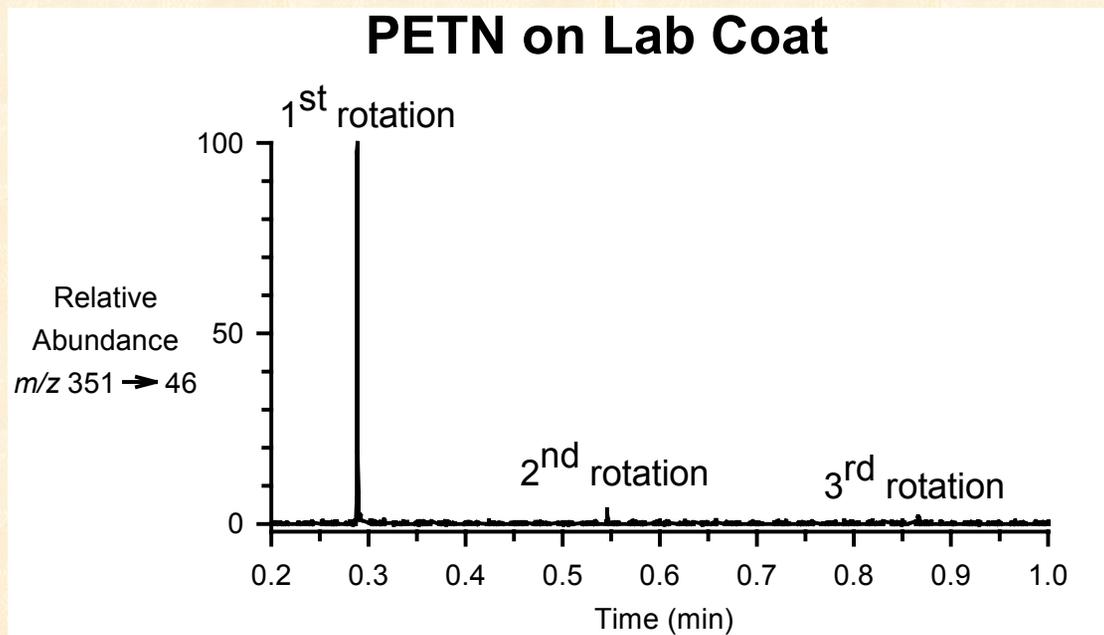
## 100 ng PETN Spiked Swipes



# Analyzing Clothing with Belt Sampler



OAK RIDGE NATIONAL LABORATORY  
U. S. DEPARTMENT OF ENERGY



Can also be used for remote sampling with a brush or toothpick to sample car interiors, cell phones



# Summary

- **Heating Block**
  - Direct Sampling of currency, mail
- **Heating Block with Automatic Feed**
  - Swipe Analysis for surfaces
  - 8/min or 480/hour
- **Heating Block with Belt Sampler**
  - Clothes
  - Also used to transfer material from a brush (sample car interiors) or a cotton swab (sample cell phone numbers).

# Summary

- **APCI Tandem MS with thermal desorption is versatile**
  - Compatible with various sampling methods
  - Ideal for various scenarios
- **High Specificity equates to low False Positives**
  - Using MS/MS transitions specific for targeted compounds
- **High Sensitivity equates to low False Negatives**

# ACKNOWLEDGEMENTS

- **Dr. Gary Van Berkel, Katie Horsman and Dr. Charles Bayne,**
- **SCIEX and Mass Spec Analytical**
- **Office of Research and Development, DOE**
- **National Security Directorate, ORNL**