

# Airborne Particulate Threat Assessment (APTA)

**Kickoff Meeting**

**November 14, 2005**

**National Energy Technology Laboratory**

ChemImage Corporation  
Pittsburgh, PA



# APTA Program Objective

- **To advance the state of knowledge of ambient background particulate matter composition.**
- **The ability of an automated aerosol detection system to operate successfully will be enhanced by a more accurate assessment of background variability, especially for sensitive and specific sensing strategies like Raman detection that are background limited in performance. Based on this improved knowledge of background, we can improve the overall threat detection performance**

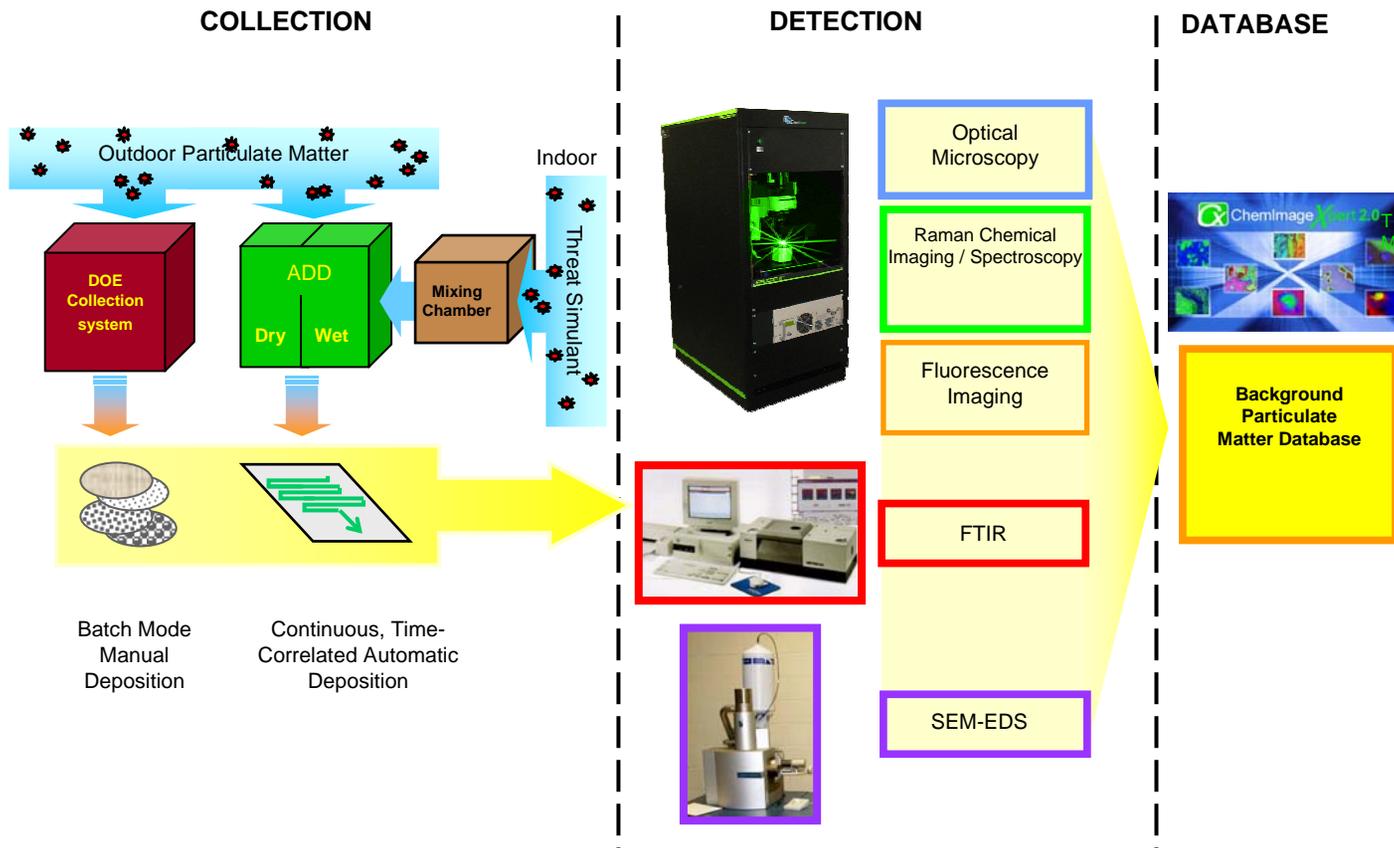


# Significance

- **Improving our knowledge base of ambient background particulate matter, with subsequent improvements in Raman sensing strategies, will be cross-cutting and will provide benefit to a host of detection efforts that have the potential to impact biodefense, homeland security, environmental monitoring and the safety of our commercial food, water and pharmaceutical infrastructure.**



# Project Scope



# Project Tasks

Task	Effort
1	<b>Assessment &amp; Setup</b> 1.1 Assessment of knowledge base 1.2 Setup and qualify PM collection equipment
2	<b>Automated Deposition System Development</b> 2.1 Investigate properties of system candidate components 2.2 Design Automated Deposition Device (ADD) 2.3 Fabricate & Test ADD
3	<b>Collection of Ambient Background Samples</b> 3.1 Collect full data sets on pure components - predeposition 3.2 Periodic collection of outdoor, ambient airborne particulate 3.3 Periodic Collection of indoor, ambient airborne particulate
4	<b>Detection</b> 4.1 Analyze collected particulate matter (PM)
5	<b>Signature Database Compilation</b> 5.1 Compile a database of signature data sets
6	<b>Final Report</b>



# Discussion

- **Raman-based detection is sensitive and specific but the technology is background-limited in performance**
- **APTA will advance our state of knowledge of ambient background and its molecular composition in western PA**
- **Improved understanding of background PM will result in improved RCI sensor performance with the potential to impact biodefense, homeland security, environmental monitoring and the safety of food, water and pharmaceutical infrastructure**



# ChemImage Corporation

## Who we are...

- Established technology company (founded 1994)
- Recognized as a leading innovator of Molecular Chemical Imaging technology solutions
- People - 50 (>40 technologists w/ expertise in Chemistry, Physics, Biology, Biomedical Engineering, Medicine and Image Processing)
- Locations - Pittsburgh, PA (Headquarters); Johnstown, PA

## What we do ...

- Invent, design and develop solutions that provide critical information for:

### Threat Detection

Technology for rapid, reagent-less detection of WMD threats

### Biomedicine

Diagnostic technology for use in:

- Cancer Diagnostics
- Heart Disease
- Infectious Disease

### Manufacturing

Products for research, development and production of:

Pharmaceuticals; Semiconductors;  
Paper; Polymers; Consumer Products;  
Food; Air monitoring; Power Generation

### Forensics

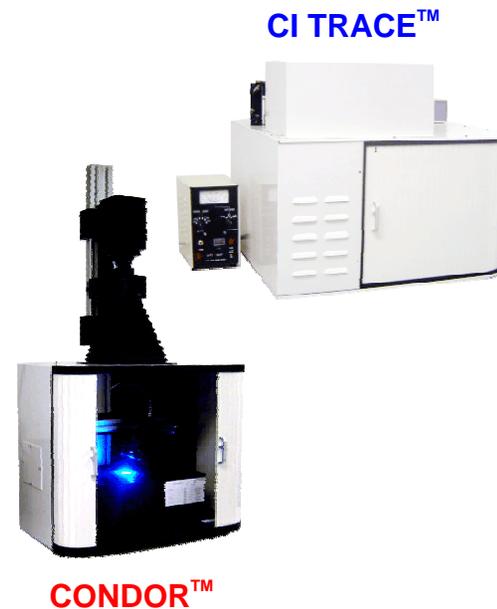
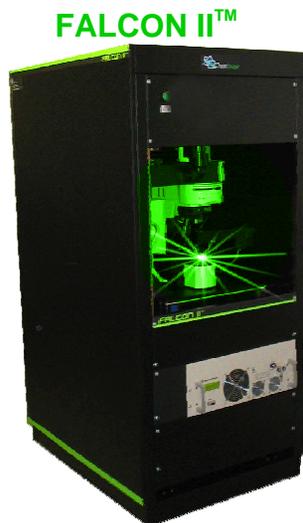
Trace evidence detection tools



# Products

## In Laboratory:

- Falcon** Raman CI Microscope
- CI Vision** Turnkey Solution
- Condor** CI Macroscope
- CI Trace** Forensics Analyzer



## In the Field:

- EAGLE** Transportable Threat Detector



## Software Solutions



# Molecular Chemical Imaging Technology

- Spectroscopy and digital imaging for the molecular analysis of materials
- Massively parallel molecular spectroscopy analysis
- Combines morphometric and molecular analysis
- Commercially mature technology

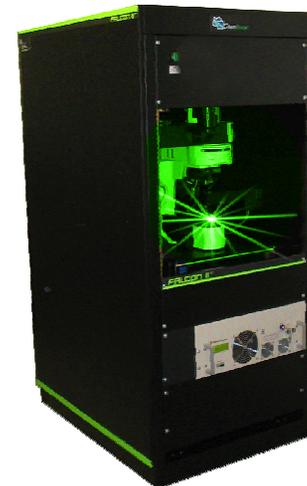
## Fluorescence Spectroscopy

- Probes electronic processes
- UV Excitation & Visible Emission
- Autofluorescence probed (no dyes or stains)
- Basis for targeting biotic material

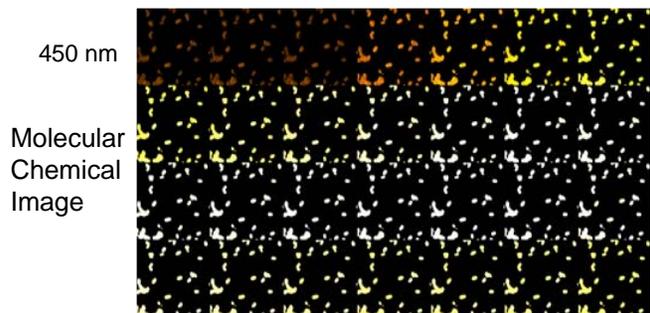
## Raman Spectroscopy

- Inelastic scattering phenomenon
- Laser based technique
- Probes energy of molecular vibrations
- Molecular “fingerprint”
- Basis for presumptive identification

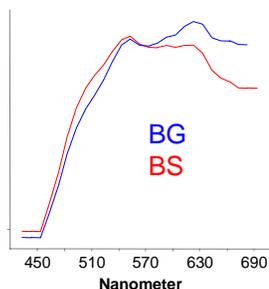
FALCON II



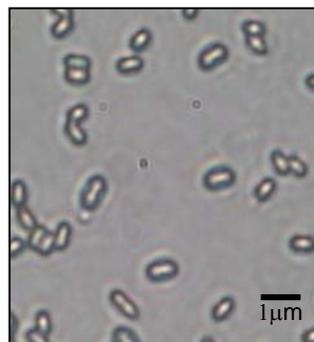
## Fluorescence Hypercube



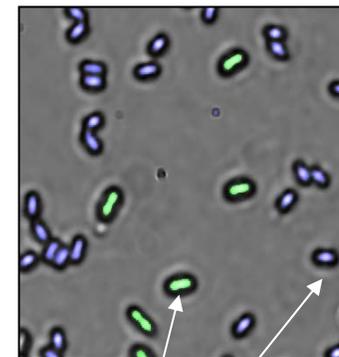
Acquisition Time:  
10 Seconds  
Information Content:  
256,000 Spectra



Optical Image of Biomixture



Molecular Chemical Image of Biomixture



**Automated classification**  
based on  
spectral and  
spatial  
properties.

BG BS



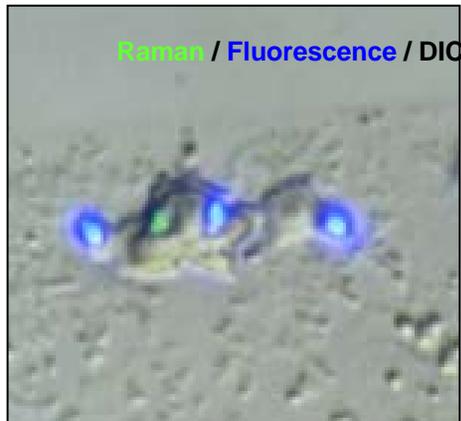
# Chemical Imaging

## Sensitive & specific detection of biotreats

Optical Imaging of Bg in JBPDS Collected  
Outdoor Ambient Air



Single spore detectable in complex background



Samples courtesy of Battelle

### Advantages for ChemBio Detection?

- High degree of specificity
- Multiple, independent detection strategies reduce false alarms
- Limited sample preparation (deposition on surface required)
- No critical reagents (primers, antibodies, dyes, stains, etc.)
- Rapid analysis time: typically 15 Minutes or Less
- Potential as identifier: species, strain & viability
- Readily digitized & communicated (networkable, field upgradeable, potential for interoperability)
- Broad spectrum detection strategy (Chem & Bio)
- Based on photonics technologies: potential as small, portable system
- Potential for low, overall cost of ownership

### Risks

- Less established than reference methods (Cell culturing, Immuno, etc.)
- Susceptible to ambient background light (daylight, fluorescence, etc.)
- Autonomous targeting specificity in the presence of clutter
- Amount of effort needed for developing and maintaining signature library
- Low rate of sampling in identification step

