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Thursday, July 9, 2020, 1 PM ET

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INTERNATIONAL HAZARDOUS MATERIALS RESPONSE TEAMS
International Association of Fire Chiefs

FTIR & Raman vs. Nerve Agents and Fentanyl: Safe Practices, Outstanding Results

Presenters: Bill Bennett and Rick Houghton

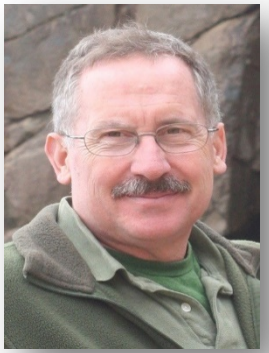
Instrumentation provided by Thermo Fisher Scientific

Our Host

Battalion Chief Michael J. Magda

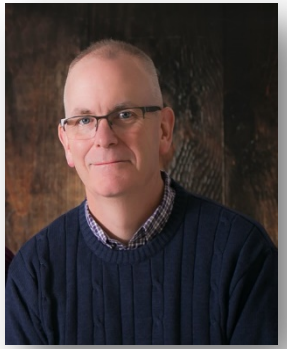
Chief Magda has served Livonia Fire & Rescue for the past 25 years and has been the Team Leader for Western Wayne County HMRT for the past 30 years. He is a retired Hazmat Manager for Michigan Task Force One, Former Technical Adviser to Michigan Hazmat MABAS committee and Owner of Magda International.

Presenters



Rick Houghton
Recently Retired SME
Houghtons, Inc.

Rick recently retired after 12 years as a Raman and FTIR trainer for Thermo Fisher Scientific. A former firefighter, Rick authored Emergency Characterization of Unknown Materials and Field Confirmation Testing for Suspicious Substances (Taylor and Francis Group).



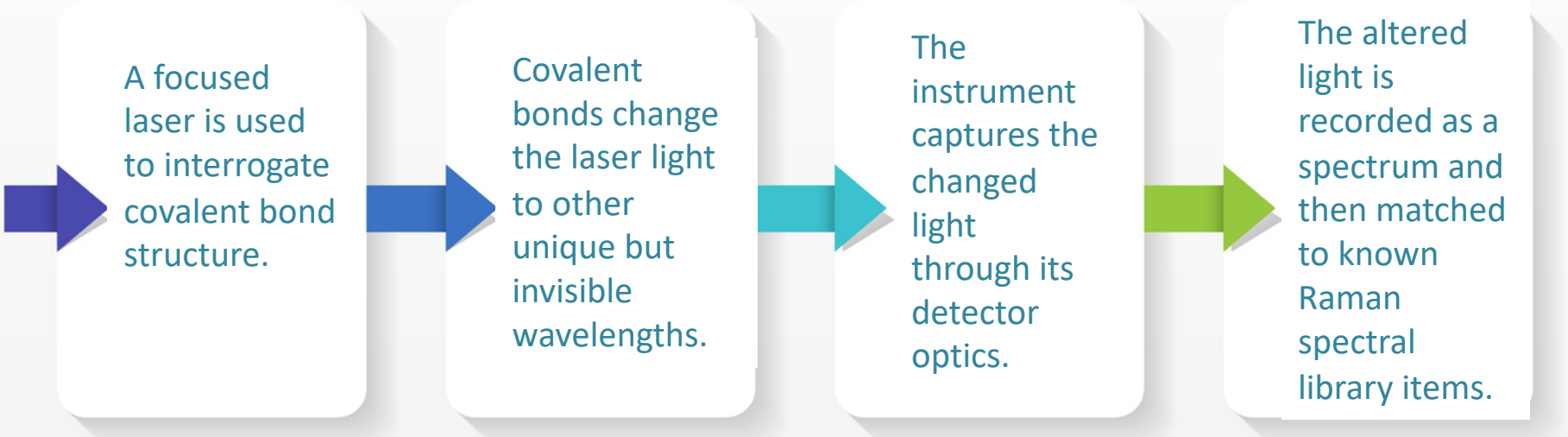
William (Bill) Bennett
President
Houghtons, Inc.

Bill has 16 years experience as a founding member of the Michigan 51st CST-WMD where he operated the mobile analytical laboratory. Bill served 32 years in the U.S. Air Force and is the lead Gemini trainer for Thermo Fisher Scientific. He is the president of Houghtons, Inc., a training company specializing in hazardous materials identification.

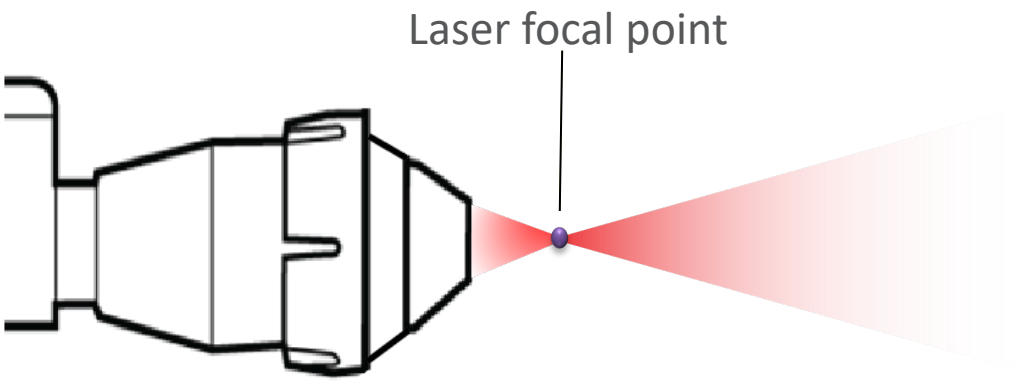
Agenda

- Raman & FTIR Operating Principles
- Safety
- Nerve Agent Overview & Analysis
- Fentanyl Overview & Analysis
- Gemini Raman & FTIR Demonstration
- Interactive Q&A

How Raman Works



How Raman Works

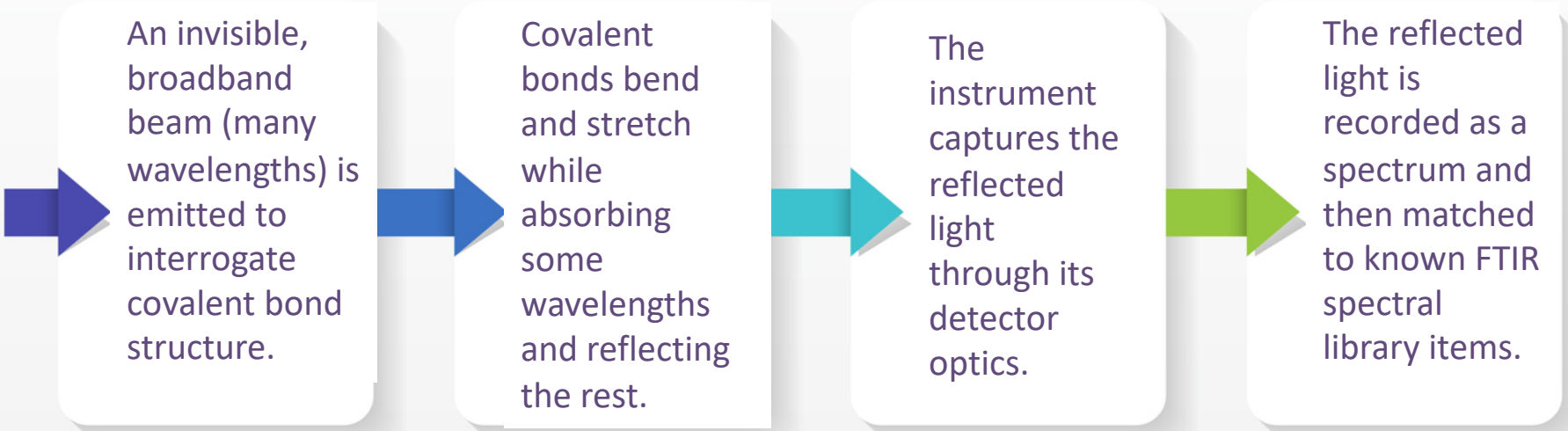


"Viewable Area"
is about 1/8-inch
either side of the
focal point

Raman: Prime vs. Challenging Conditions

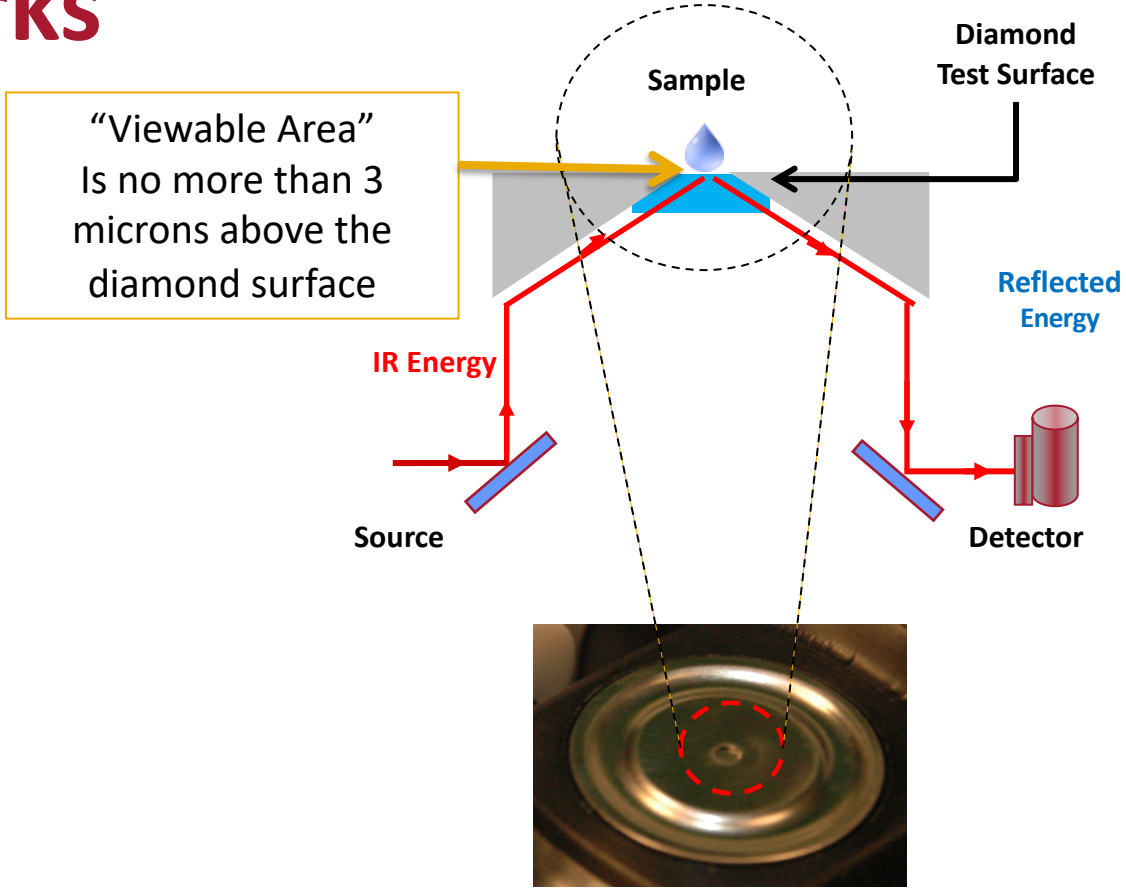
Prime	Challenging
Samples with strong Raman signal response	Low or no Raman reactivity
Consistent ambient light conditions	Darker colored materials or containers
Sample proximity and background	Inconsistent conditions
Minimal sample	
Sample manipulation	

How FTIR Works



How FTIR Works

- Samples must make full physical contact across the diamond test surface
  - Solids must have full contact across the diamond
  - Liquids uniformly flow across the surface of the diamond



FTIR: Prime vs. Challenging Conditions

Prime	Challenging
Samples with strong FTIR responsiveness	Low or no FTIR responsiveness
Clean diamond with good background scan	Instrument movement
Full sample contact across the diamond surface	Inconsistent conditions
Minimal sample	
Sample manipulation	

Complementary Technologies

FTIR
11,000+ items

Better for:

- Thermally sensitive materials
- Fluorescent samples

Combine for 14,000+ items and mixtures of about 4 ingredients

~70%

No response:

- Metals
- Elements
- Simple Ionics

Raman
12,000+ items

Better for:

- Substances in water
- Pressure-sensitive substances
- Material in transparent or translucent containers

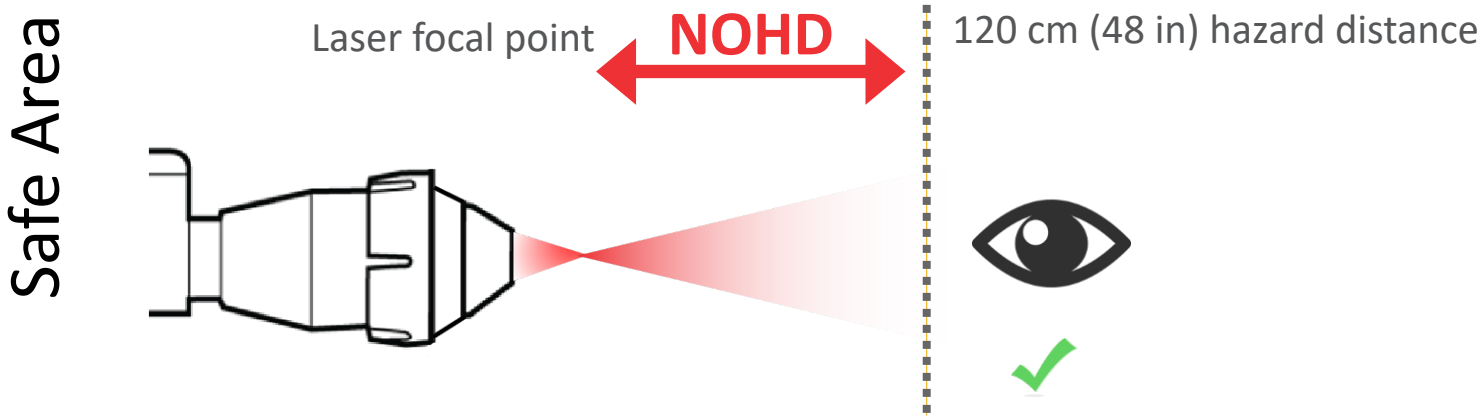
Raman Laser Safety

- Full laser safety training is included with product training
- All Raman instrument operators required to receive laser safety training

Safety Concerns: | Eye | Fire

Raman Laser Safety

- The Nominal Ocular Hazard Distance (NOHD) is **no greater than** 120 cm (approximately 48 in)
- Eye exposure within the NOHD is capable of injuring an eye
- The Nominal Skin Hazard Distance (NSHD) is no greater than 10 cm (4 in)



Enhancing Raman Laser Safety

- **Liquid in a vial**
  - 5 drops is adequate
  - 2 drops if instrument is tilted 45°
  - Leave the cap on (liquids will not ignite in vial)
- **Solid in vial compartment**
  - 300 mg (pea-size) is adequate
  - Remove cap on possible energetic material to prevent confinement, but consider inhalation hazards such as fentanyl and organophosphates
  - Do not stand over the vial compartment in case of reaction
- **Solid with manually positioned probe**
  - Consider a pinhead-size amount on matte finish tape in a safe area
- **Onboard tools**
  - Scan Delay
  - Scan Timeout
  - Adjust laser power

FTIR Safety

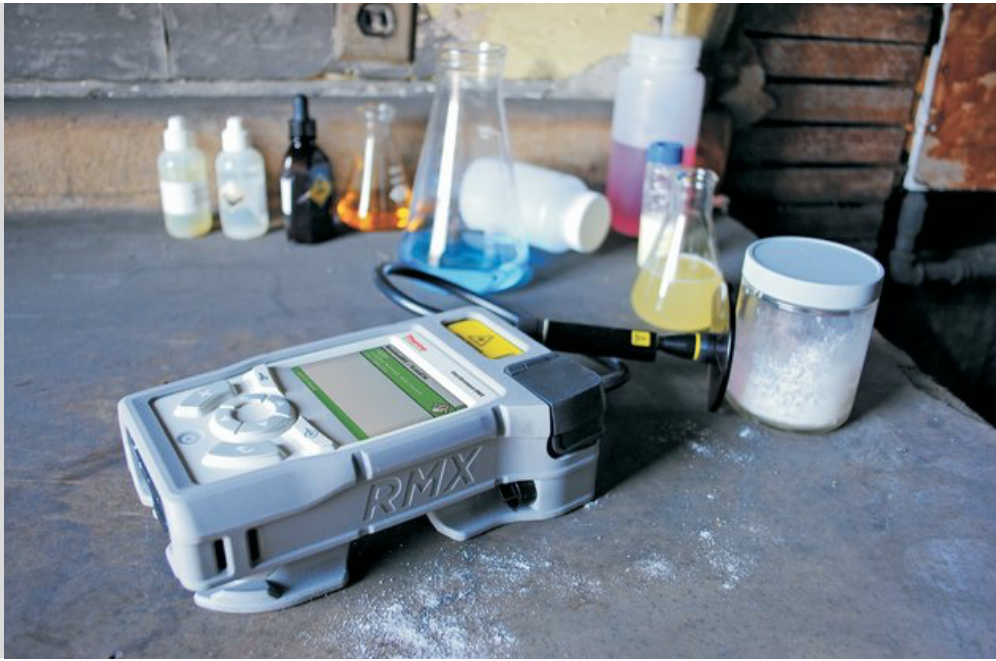
- **Pinch point hazard**
  - Automated moving anvil (Gemini™)
  - Up to 11 pounds pressure
  - Keep fingers clear
- **Explosion hazard**
  - Pressure, shock, and friction-sensitive substances may react (e.g., TATP, gunpowder, nitroglycerine, match tips, etc.)
  - Minimize sample size – no more than what covers the diamond
- **Onboard Tools**
  - Reduce anvil pressure (Gemini™)
  - Scan Delay
  - Scan Timeout

Nerve Agents

- Most toxic of chemical warfare agents
- Disrupts the nervous system by interfering with acetylcholinesterase
- Indicators of a potential nerve agent release
  - Threats/Intelligence identified
  - Supplies or containers discovered
  - Dispersal device discovered
  - Chemical PPE

Nerve Agents

- Human signs and symptoms of nerve agent exposure
  - Fasciculations (muscle spasms)
  - **SLUDGEM** salivation, lacrimation, urination, defecation, gastrointestinal upset, emesis, miosis (pinpoint pupils)



Nerve Agent Detection & Identification

Physical characteristics

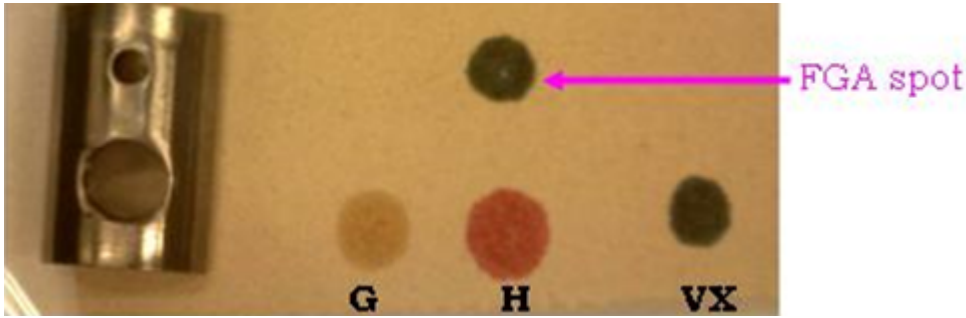
- Colorless to brownish
- Consistency ranging from liquid solvents
- All are covalently bonded organic chemicals
- Generally heavier than air

Nerve Agent Detection & Identification

- Presumptive Identification
  - Raman and FTIR
    - Suitable for visible amounts
    - Highly Raman and FTIR reactive
    - Minimal sample required
    - Interrogate with Raman and FTIR whenever possible
    - May identify precursor and degradation chemicals
    - Raman
      - Vial mode is best
      - Point and shoot mode is an option for evidence preservation
    - FTIR
      - Sample manipulation on the diamond may be necessary to delay volatilization

Nerve Agent Detection & Identification

- Presumptive detection
  - M8 Paper
    - Organic liquid chemicals absorb into M8 paper



Absorbed nerve agents cause M8 paper color changes:

- Yellow 'G' Series (sarin, soman, tabun)
- Green 'V' Series (VX)

Initial yellow changing to green after about 10 second is characteristic of 'A' Series FGA

Fentanyl

- Estimated to be 80 times as potent as morphine and hundreds of times more potent than heroin
- Weaponizable but most often used illicitly as a drug of abuse
- May be disseminated in air, water, and food

Fentanyl

Routes of exposure include inhalation, ingestion, and skin contact

Produces delayed reduced respiratory function (respiratory depression) and eventual respiratory arrest

Most often appears as a crystalline powder

Fentanyl

- Presumptive analysis with Raman and FTIR
  - Numerous analogs exist but all are covalently bonded chemicals making Raman and FTIR an excellent choice for field analysis
  - Thermo Scientific TruNarc™
    - Handheld Raman analyzer of over 300 narcotics, stimulants, depressants, hallucinogens and analgesics.
    - Frequently updated Raman and FTIR libraries contain most fentanyl spectrums

Video Demonstrations

- Demo-1 Raman - Potential nerve agent through a container
- Demo-2 Raman - Potential explosive material on tape
- Demo-3 Raman - Complex sample separation
- Demo-4 Raman - Fentanyl simulated in tape
- Demo-5 FTIR - Liquid nerve agent simulation

Questions

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