Real-Time Chemical Exposure Assessment with Detection Gear: Possibilities and Trends

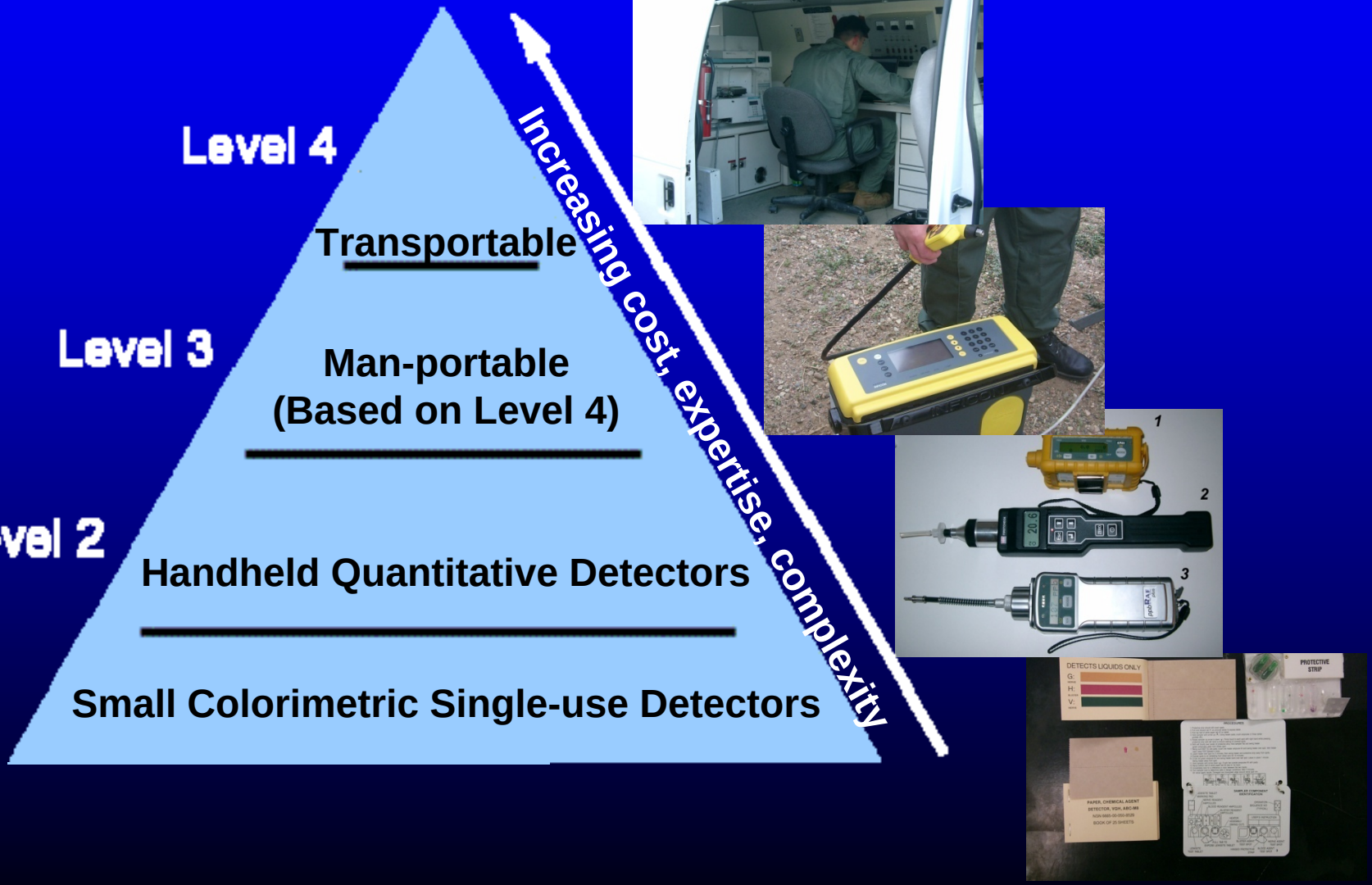
Objectives

Discuss the possibilities of real-time detection and identification

Briefly review important types of systems available for field chemical detection

Describe trends in real-time detection and identification tools derived from laboratory gear: the ideals of “faster,” “cheaper,” and “easier-to-use”

Types of Real-Time Exposure Assessment Tools



Definitions

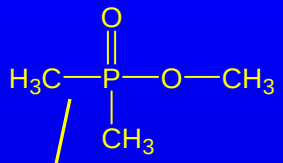
In this presentation “real-time detection/identification” refers to work completed using lab-grade tools in the field (apex of pyramid)

Trends in this type of real-time detection and identification tool are now accelerating towards the ideals of “faster, cheaper, and easier-to-use”

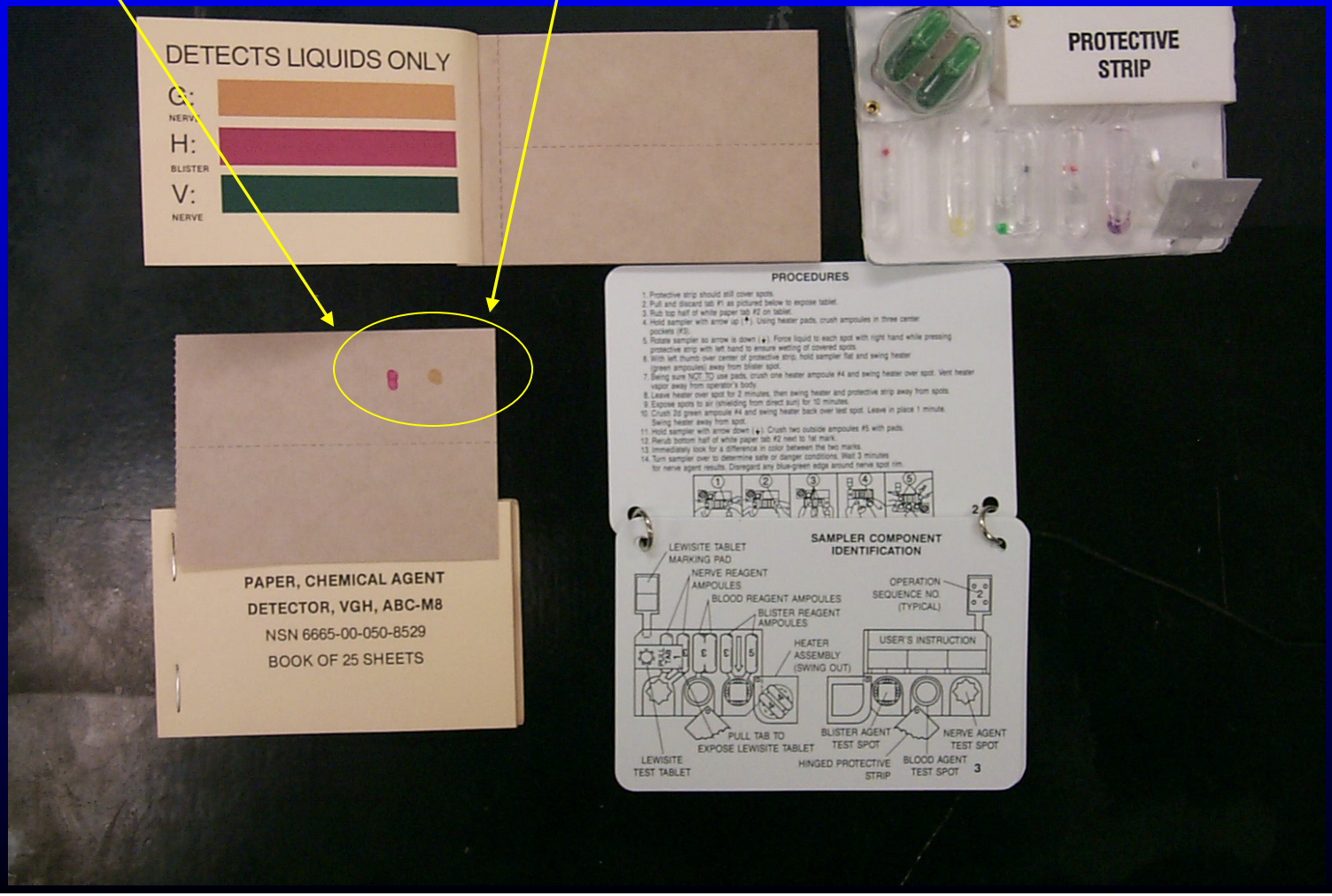
Level 1 Gear

Some Capabilities without Instrumentation

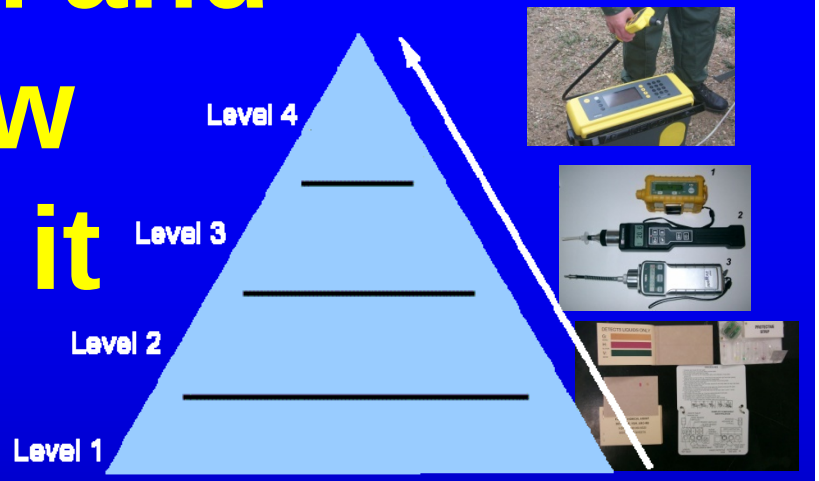
M8 Paper (simple)



M256 Kit (complicated)



Real-time detection and identification is now possible; why isn't it routinely used?



Lower level tools (pyramid base) exposure assessment tools have existed for some time, providing useful, but not definitive data for guiding exposure assessments

These lower level tools do not:

(1)Identify unknowns
(2)Provide high certainty data

Level 2 Gear

Photoionization Detector

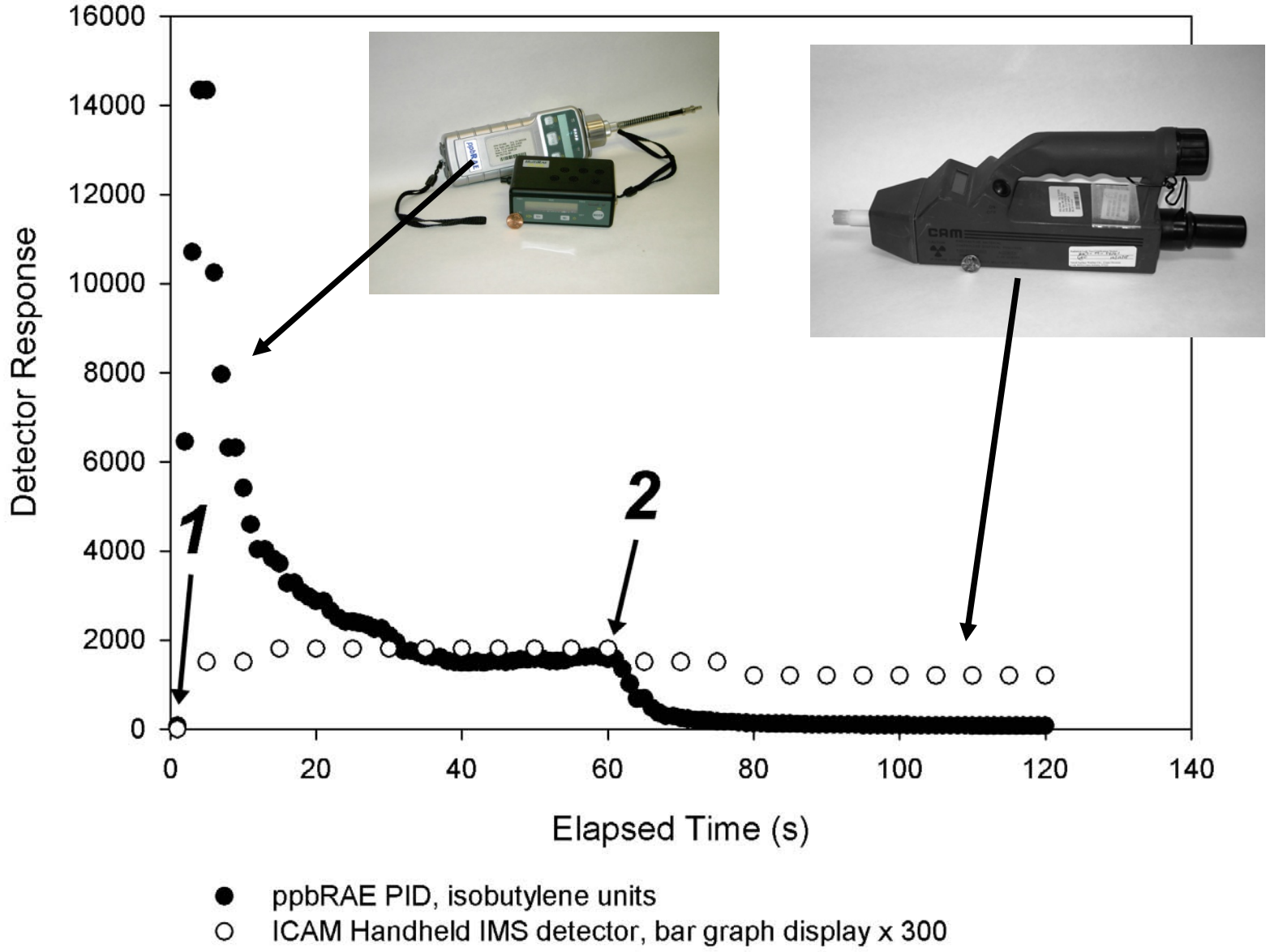
A simple and rugged instrument that uses relatively little power

Relies on atmospheric pressure photoionization of target analytes (makes for selectivity based on ionization potential)

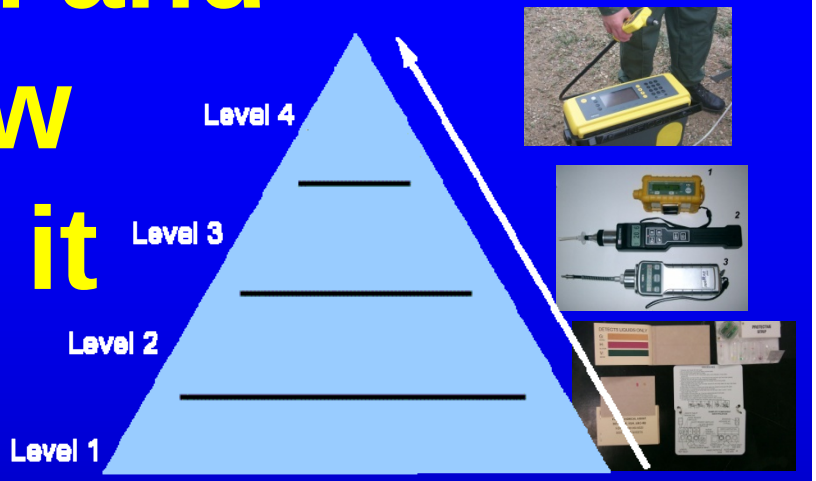
Level 2 Gear

Ion Mobility Spectrometry

- At one time known as “Plasma Chromatography” (a misnomer)
- A simple and rugged method that uses relatively little power
- Relies on atmospheric pressure chemical ionization of target analytes; selectivity based on ionization chemistry and ionization potential)


16000
14000
12000
10000
8000
6000
4000
2000
0
Detector Response
0
20
40
60
80
100
120
140
Elapsed Time (s)
1
2
ppbRAE PID, isobutylene units
ICAM Handheld IMS detector, bar graph display x 300

Real-time detection and identification is now possible; why isn't it routinely used?



Numerous level 2 exposure assessment tools are recently available; these provide field data for unique stressors OR provide quantitation (with proper calibration)

These types of mid-level tools do not Identify unknowns, but can provide quantitative data when analytes are known

Level 3 and Level 4 Gear

Spectrometric Instruments

Infrared Spectroscopy

Mass Spectrometry (usually with gas chromatography)

Field-Portable IR

Good example of level 3 equipment:

Man-portable, derived from lab gear, only recently available

Field-Portable GC-MS

Reasons that high-level real-time detection and identification are not routinely used in completing exposure assessments:

-Expense

-Complexity

-It's a new idea

(a) We aren't used to considering that this type of tool could have a role in exposure assessment

(b) We are not sure what that role could be

What are we Currently Missing in Exposure Assessments?

You don't know unless you look…

Irradiated Mail

Field identification was required at the point of contaminant generation to answer fundamental exposure assessment questions ; numerous volatile, irritating chemicals were shown to be produced by the irradiation process

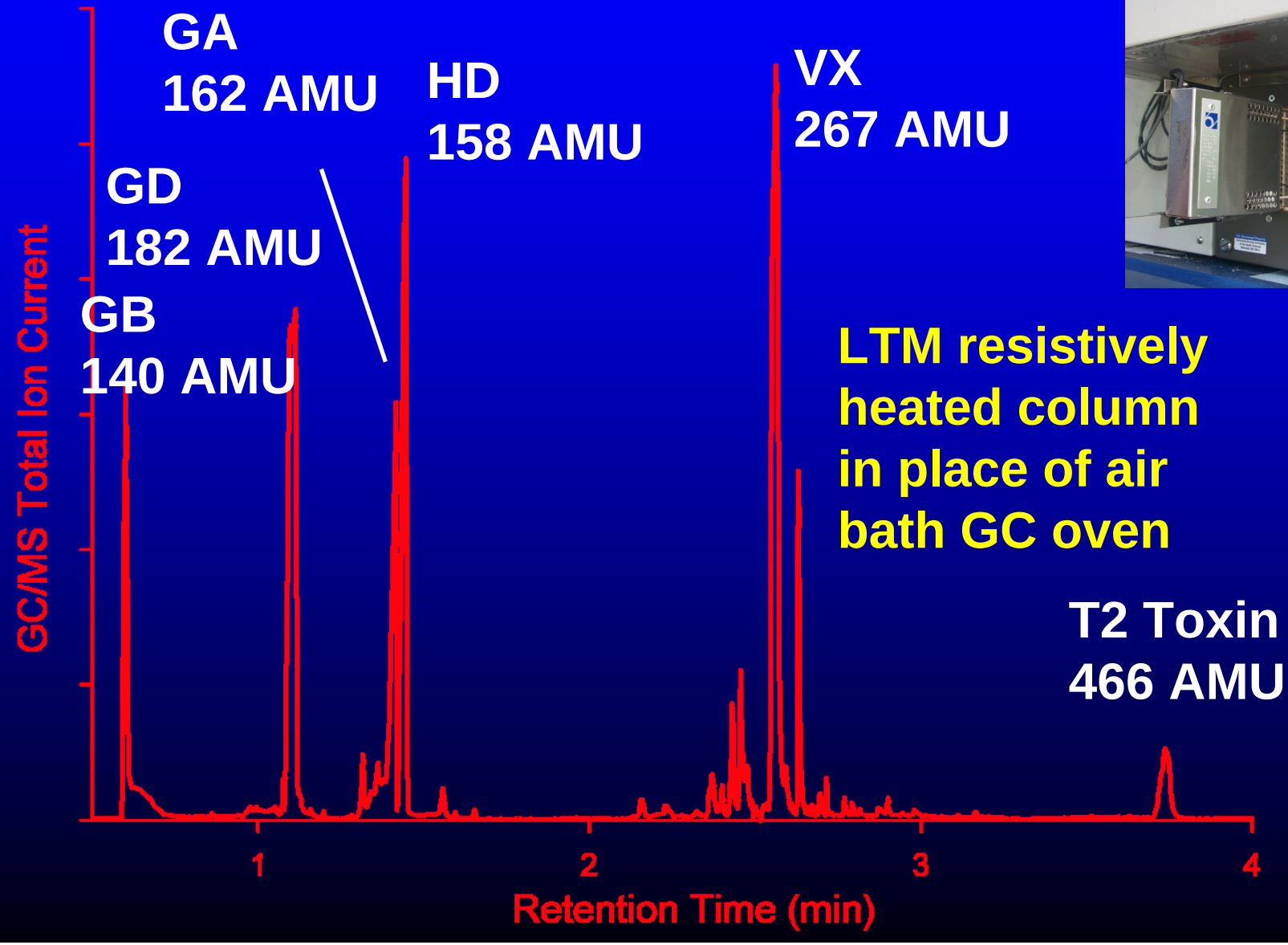
Trends for “High-End” Instrumentation

smaller, faster, less power…

Typical GC air bath oven

Rapid Combined Sampling/Analysis

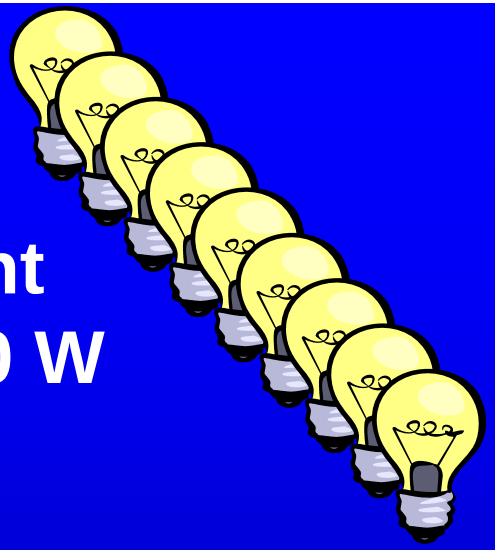
5 min SPME sample from contaminated water



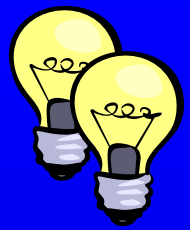
LTM resistively heated column in place of air bath GC oven

T2 Toxin
466 AMU

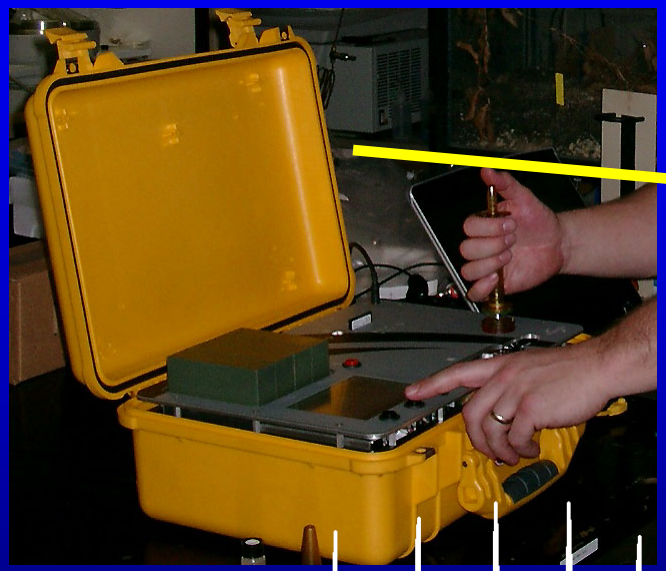
Agilent GC: 900 W

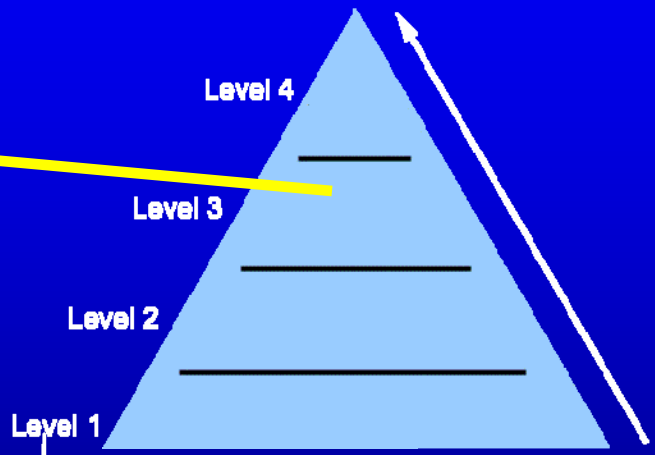


LTM GC: 200 W

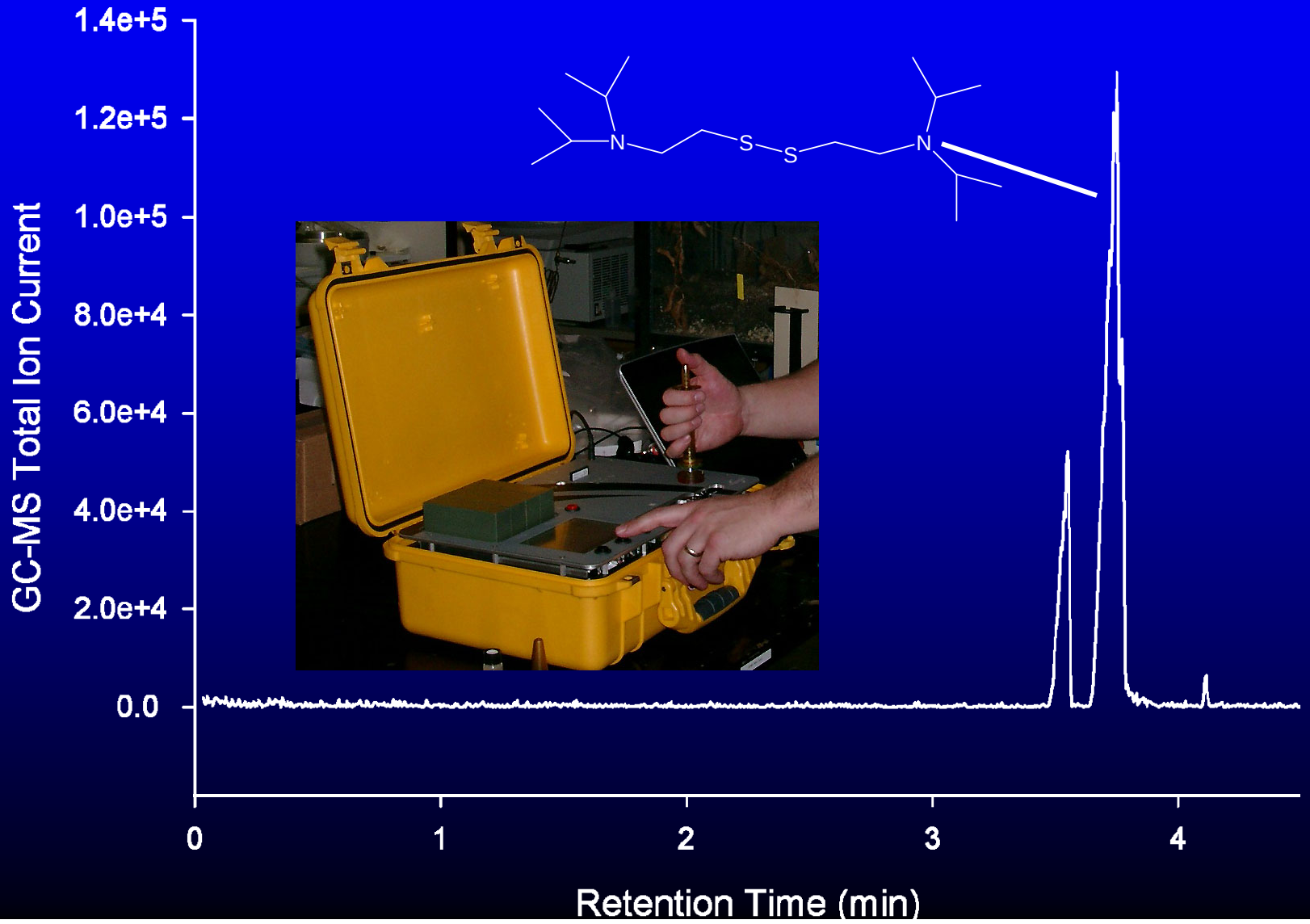


Expanding Into Level 3: GC-MS with Near Lab-Grade GC Performance in 28 lb Man-Portable Instrument





Detection of Low-Volatility Analyte (320 amu) with Combined Sample and GC-MS Analysis Time of < 5 minutes



Conclusions

High-performance spectrometric instrumentation becoming more fieldable, less expensive

Available “simple” detectors have different strengths and weaknesses but none available to provide real-time detection/identification

IHs have plenty of work ahead of us to master available tools, design useful strategies, and new tools