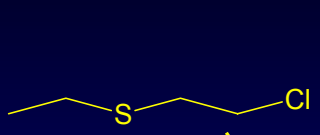
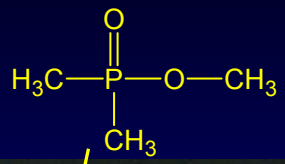
Detection of Gas Phase Chemical Warfare Agents using Field-Portable Gas Chromatography-Mass Spectrometry Systems: Instrument and Sampling Strategy Considerations

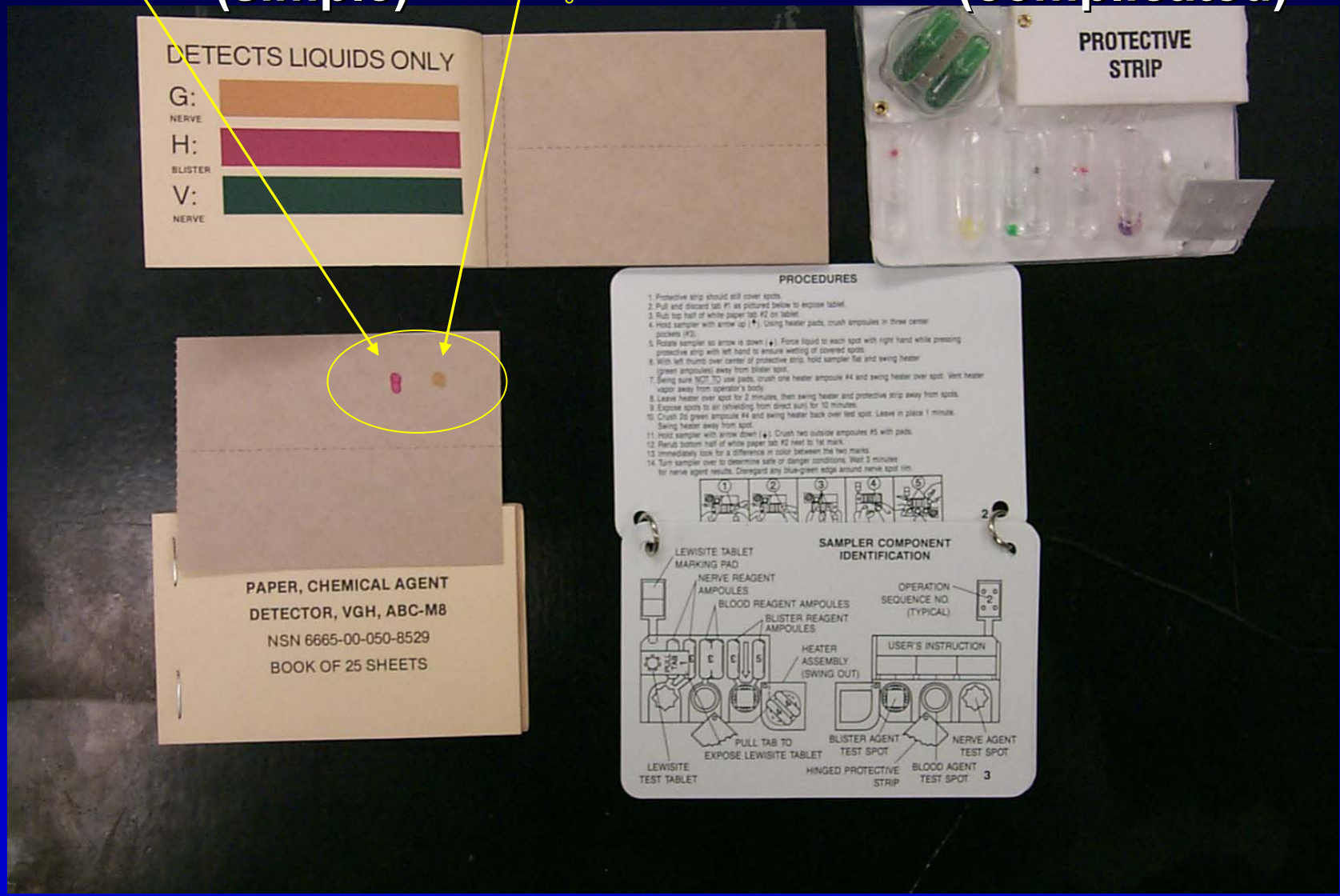
Capabilities without Instrumentation



M8 Paper (simple)



M256 Kit (complicated)



Why use GC-MS?

(1) “Gold standard” orthogonal data provided

(2) Capable of identifying unknown compounds by mass spectrum match

Arguing against GC-MS use:

(1) Large, power-hungry instrument

(2) Spectral interpretation can be difficult

(3) Sample prep, analysis can take considerable time

GC-MS “guts” -two approaches

Resistively-heated LTM GC column

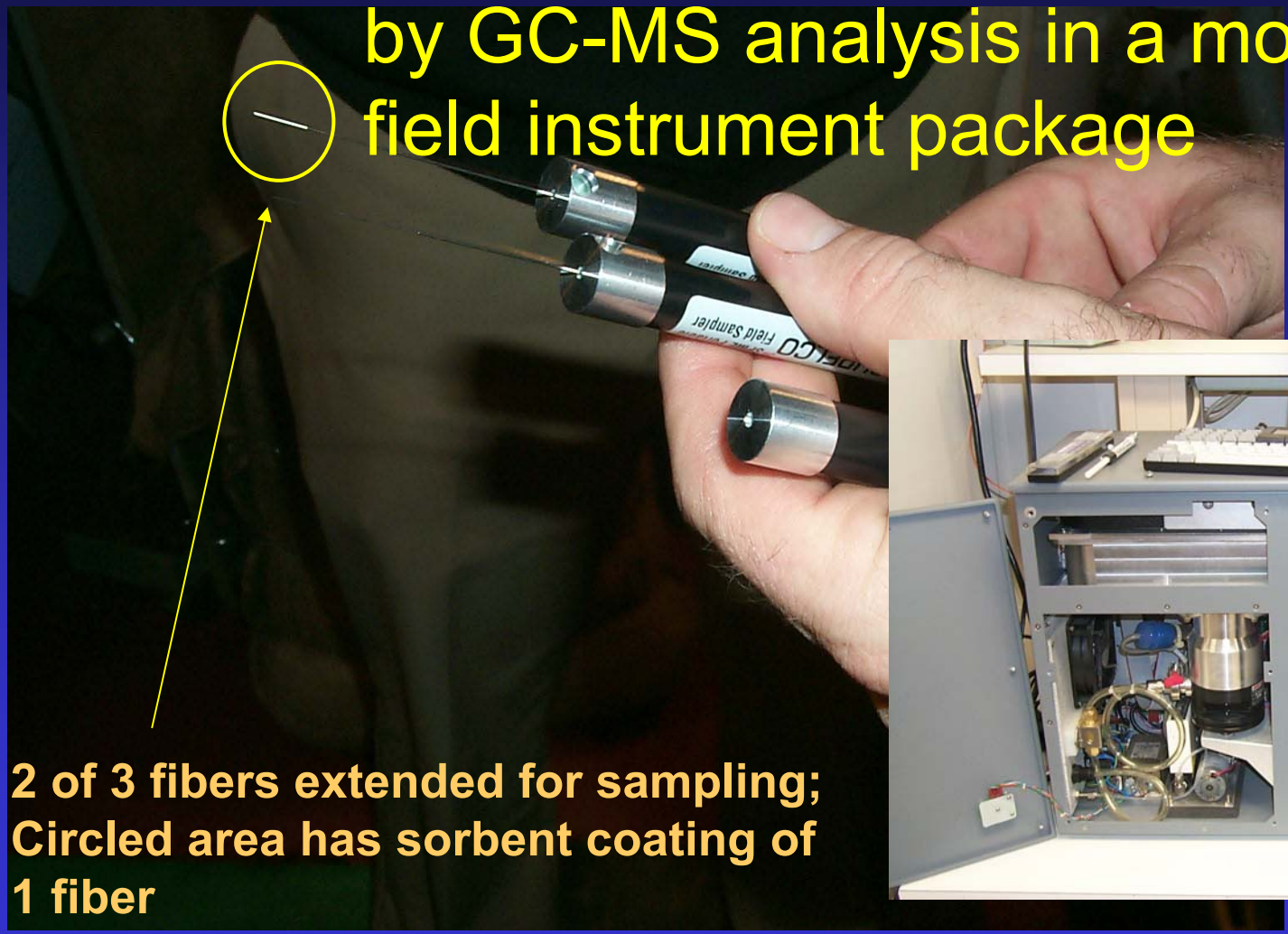
Man-portable instrument

Field-portable instrument

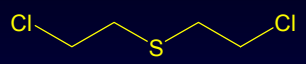
Man-portable GC-MS system

Alternate Approach

Solid Phase Microextraction (SPME) as field sampling method, followed by GC-MS analysis in a more capable field instrument package

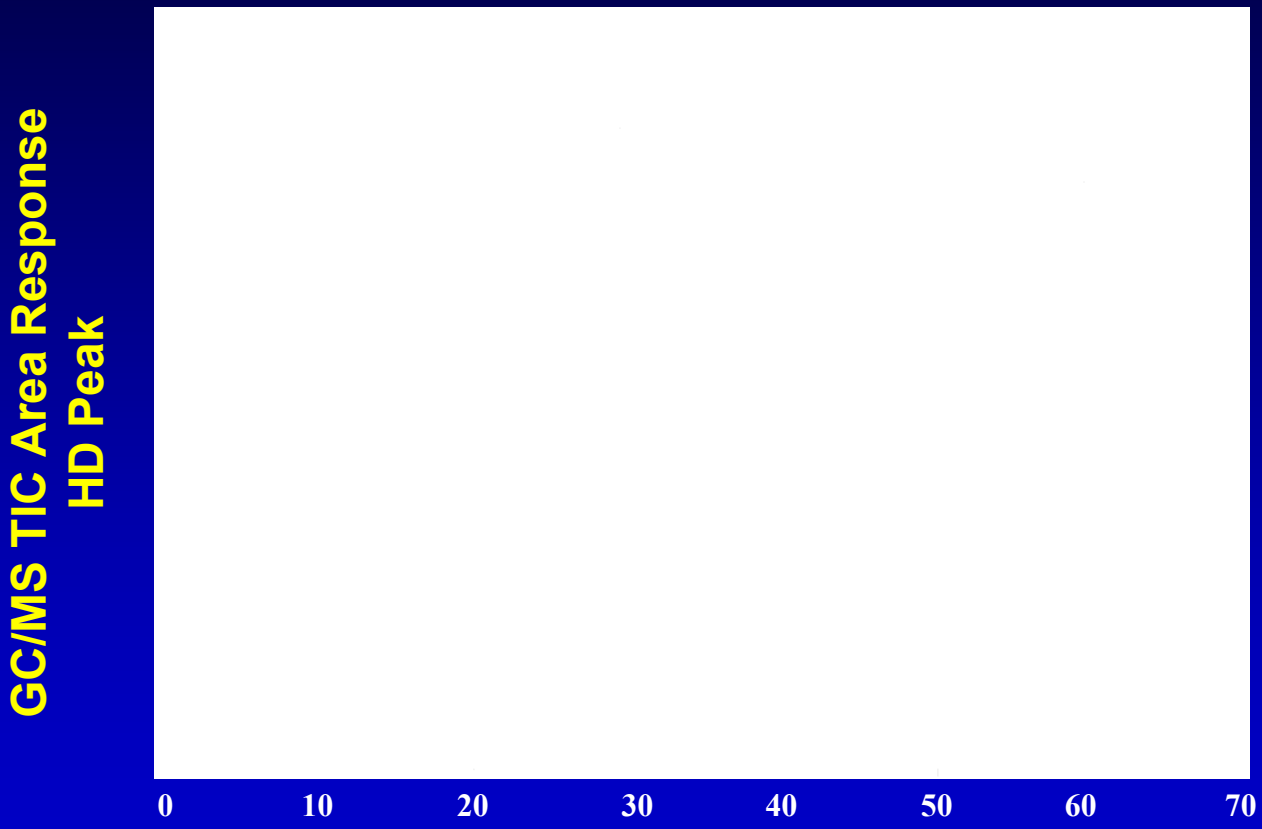


2 of 3 fibers extended for sampling; Circled area has sorbent coating of 1 fiber



CW/DVB & PA Fiber Uptake

HD, 12 μg in 15 mL vial
Headspace, Ambient Temperature

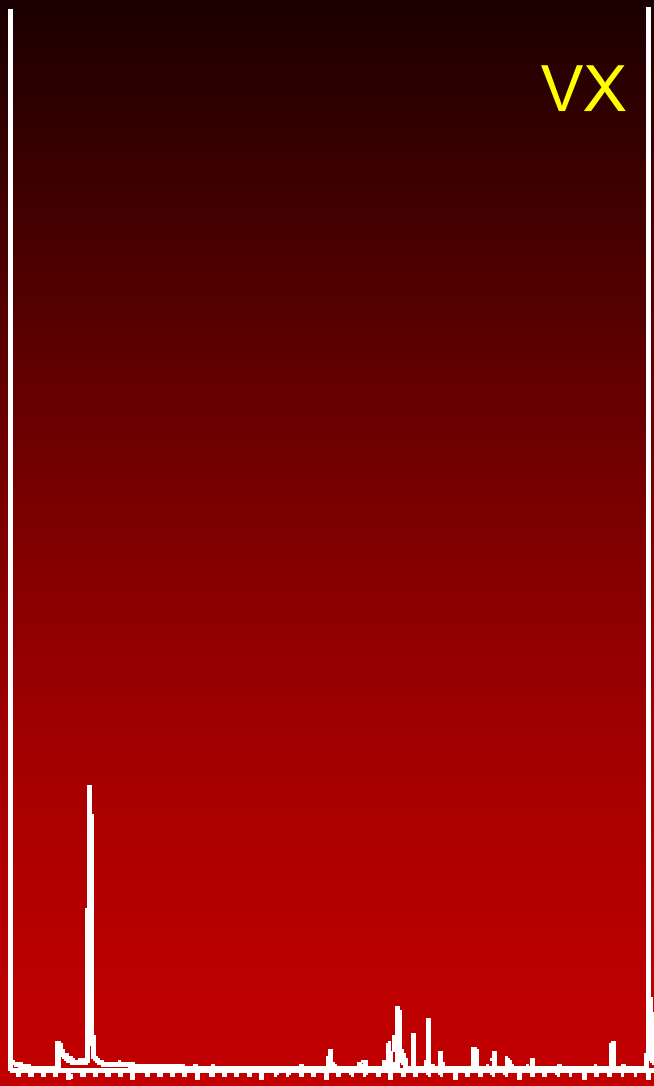


Sarin (GB)

1 minute passive gas-phase SPME sample, mobile-lab analysis

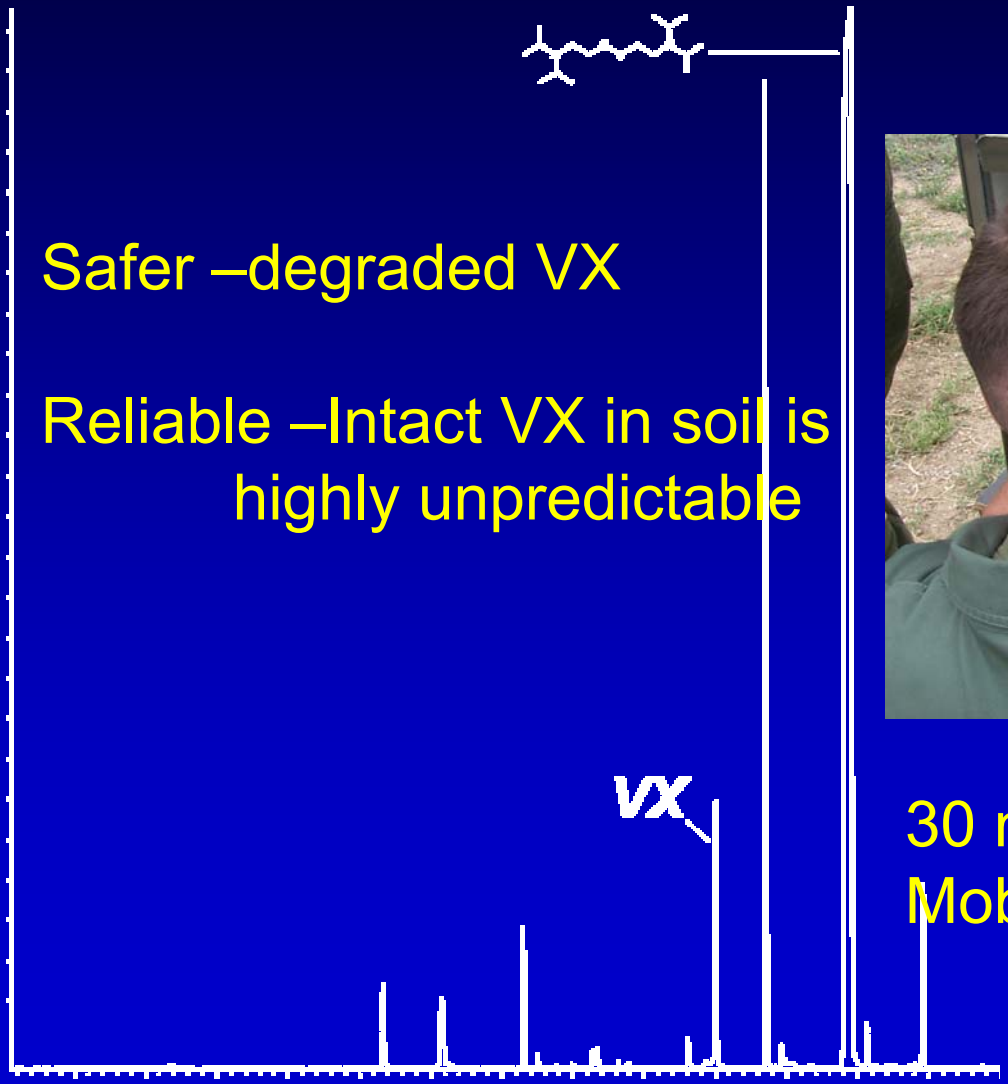
Sulfur Mustard (HD)

1 minute passive gas-phase SPME sample of contaminated cloth -mobile-lab analysis



1 μL VX applied to 5 cm^2 undershirt material
1 minute passive headspace SPME sample, 50 ˚C
Mobile-lab field analysis

VX Degradation SPME Method

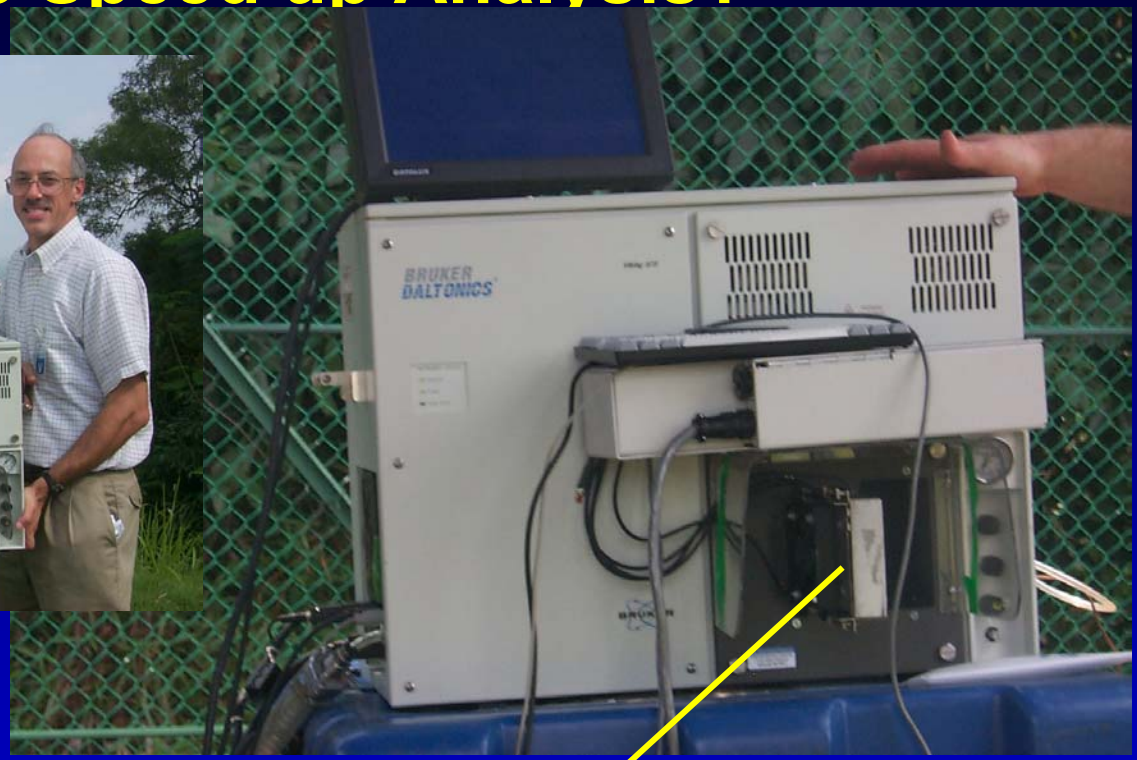


Safer –degraded VX

Reliable –Intact VX in soil is highly unpredictable

30 minute passive SPME sample
Mobile-laboratory field analysis

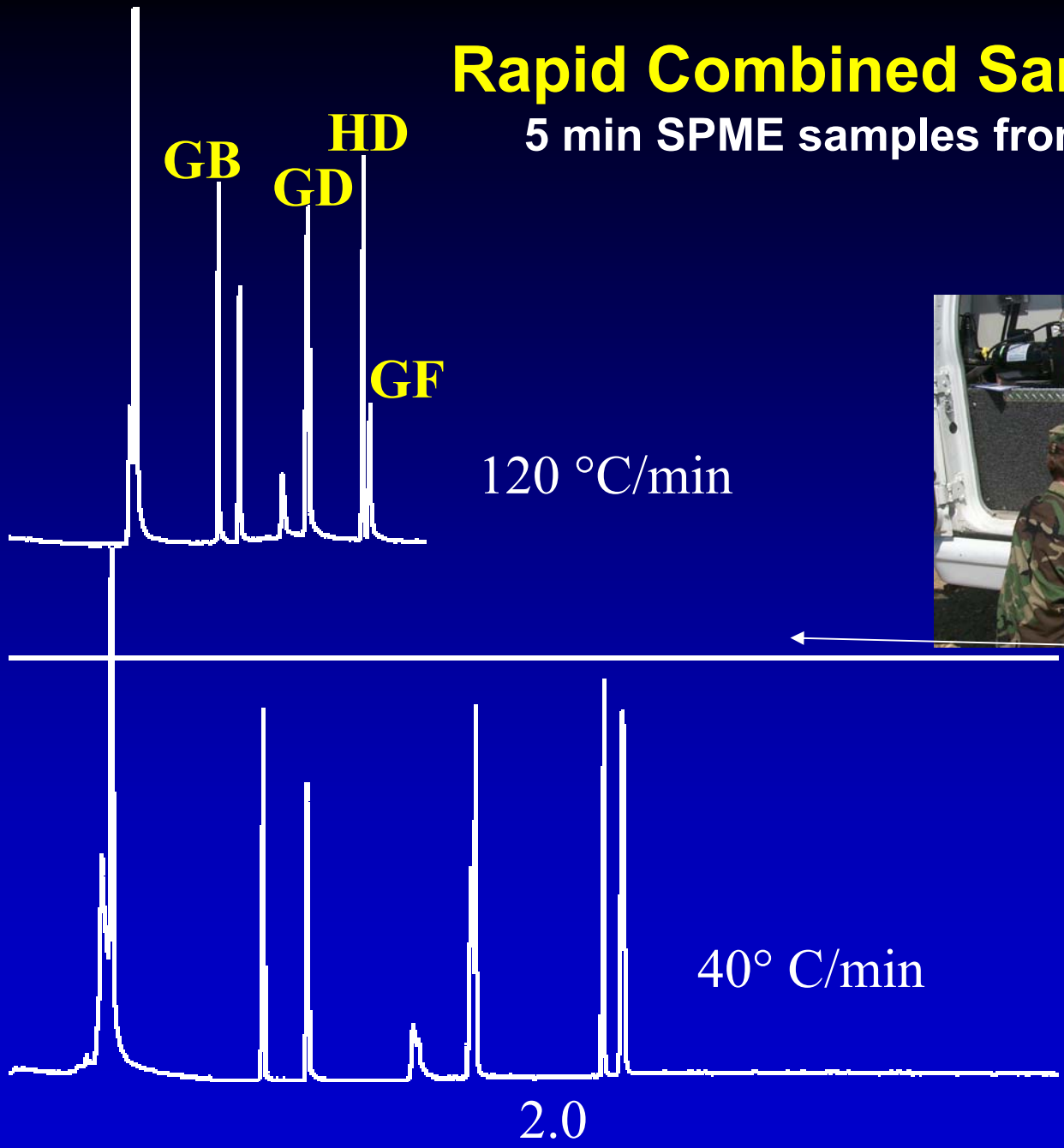
Fast Sampling has been shown with SPME
Can we Speed up Analysis?



Resistively heated LTM GC column
(externally mounted)

Rapid Combined Sampling/Analysis

5 min SPME samples from contaminated air



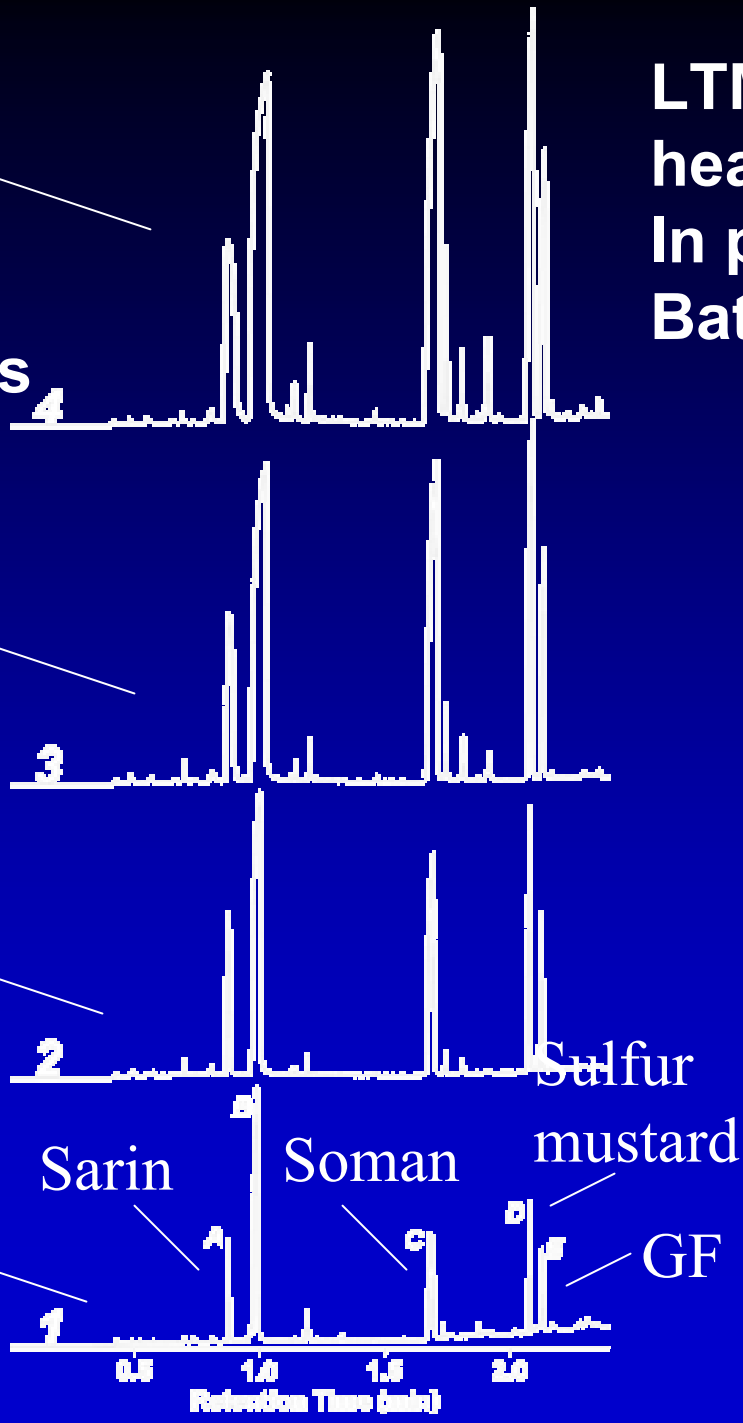
Use low thermal mass resistively heated column In place of air Bath GC oven

30s SPME

Headspace
Above
Contaminated Cloth

2.5 min total analysis

LTM resistively heated column In place of air Bath GC oven



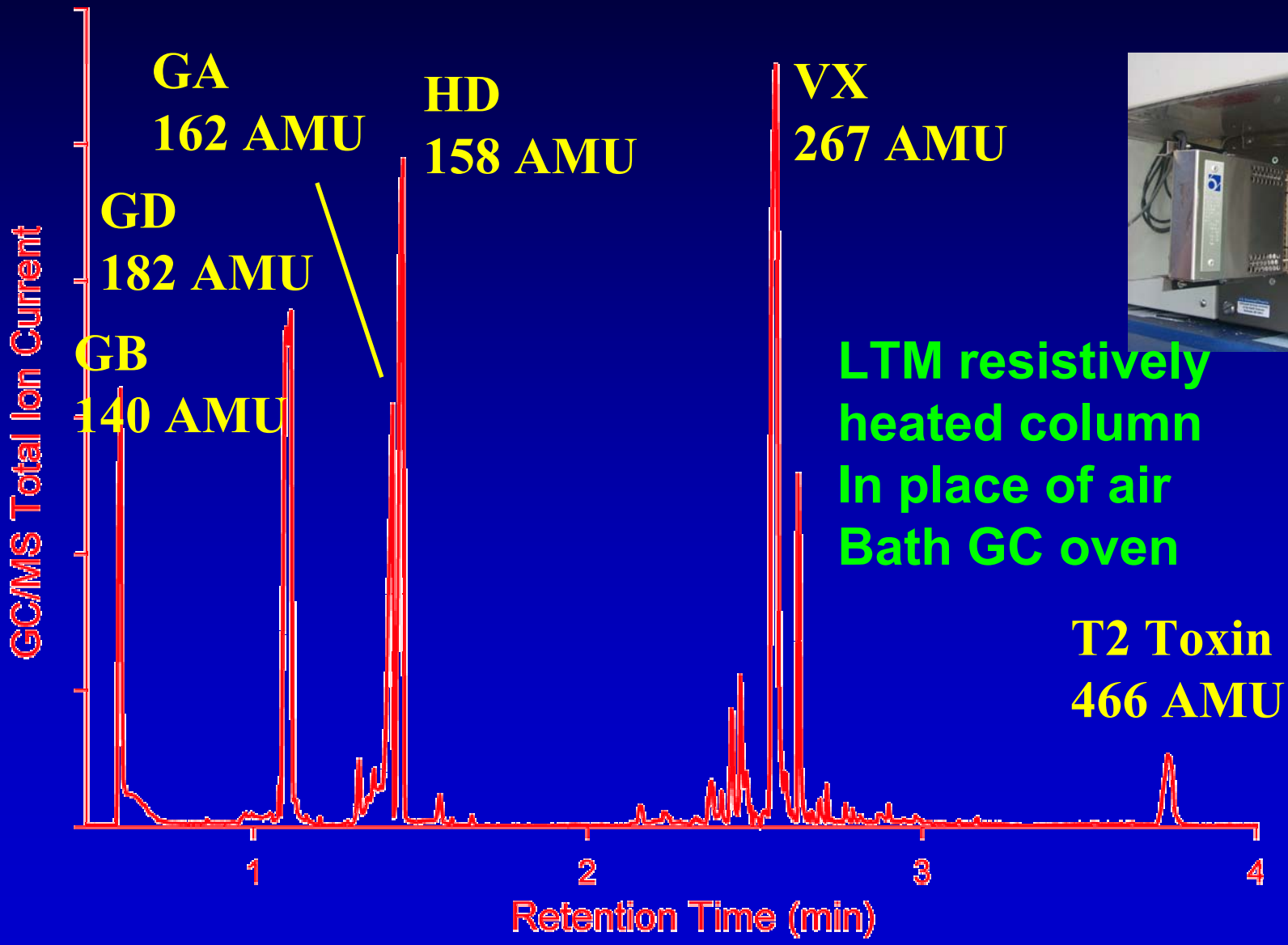
15s SPME

2s SPME

1s SPME

Rapid Combined Sampling/Analysis

5 min SPME samples from contaminated water



LTM resistively heated column In place of air Bath GC oven

Need: Test atmosphere with a wide range of chemicals having different properties

Hapsite and SPME sampling selectivity can be studied with such an atmosphere

5 min passive SPME
Sample shown here,
field GC/MS analysis

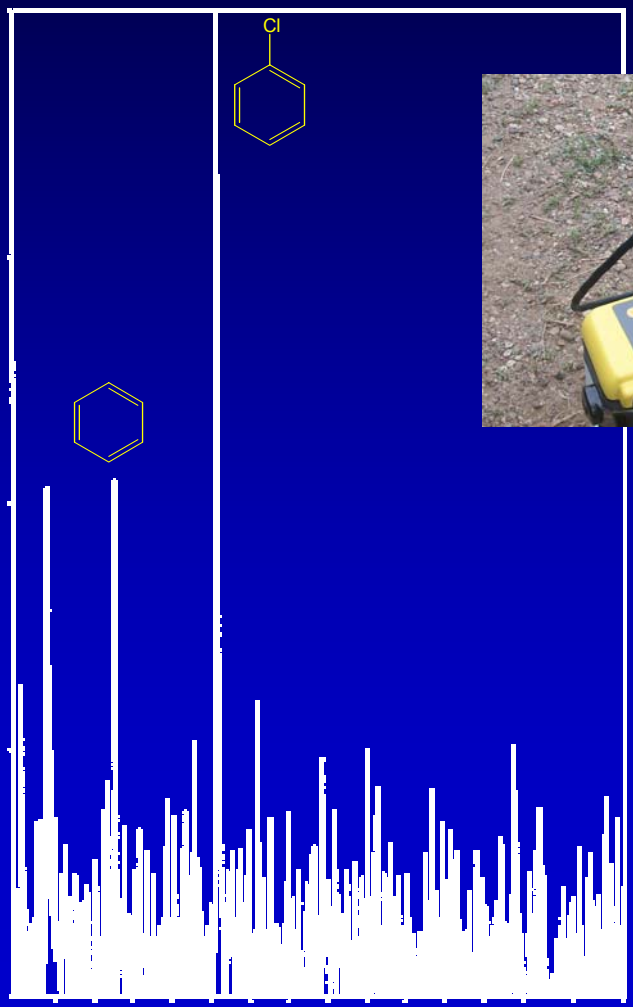
Hapsite sampled successfully for Volatiles in this range (next slide)

Hapsite Selectivity

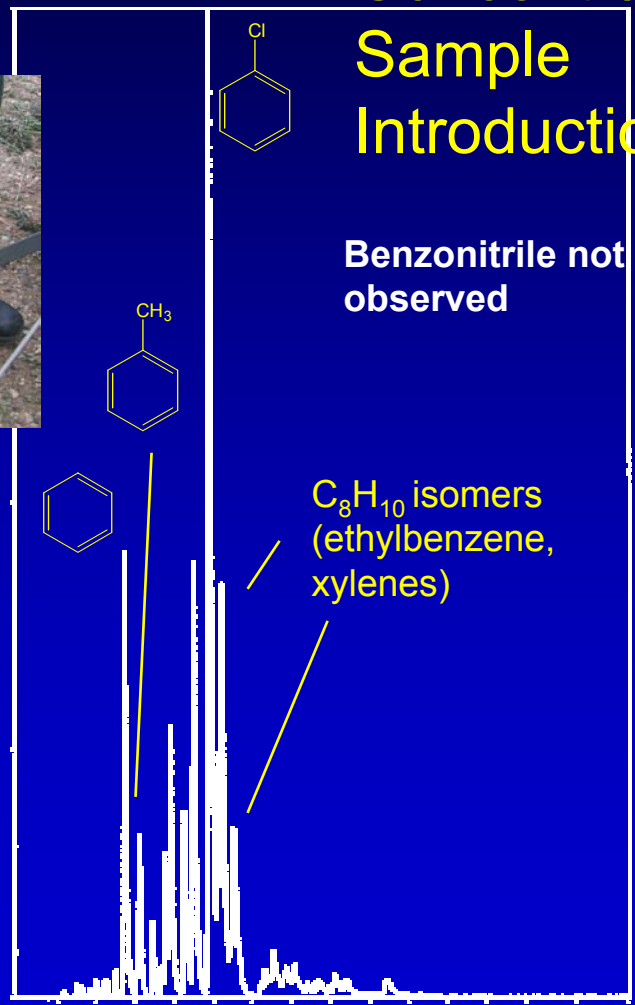
Same atmosphere sampled as previous slide

only light compounds observed

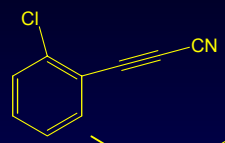
Gas Loop Sample Introduction

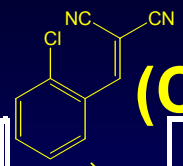


Tenax Concentrator Sample Introduction



Benzonitrile not observed

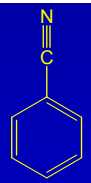


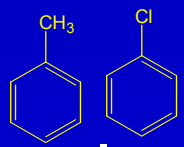


(CS)

5 min passive SPME
Sample shown here,
field GC/MS analysis

Hapsite sampled successfully for Volatiles in this range (previous slide)





	Hapsite	Hapsite (MS-only)	SPME/GC-MS
Mass of sampler	16 kg	16 kg	0.035 kg
Sample throughput	3/hr	>10/hr?	>10/hr?
GC/MS systems and operators needed for 10 samples/hr	3	1	1
Cost for GC-MS System(s) sufficient for 10 samples/hr	$300k+	$100k+	$140k

Next?

Build prototype low thermal mass GC column mated directly to a mass spectrometer –a drastic reduction of mass, footprint, and volume with superior heating/cooling characteristics

Laboratory-grade instrument capabilities without the van