
Infrared Active Open-Path Spectroscopy to Measure Chemical Agents and Hazardous Air Pollutants



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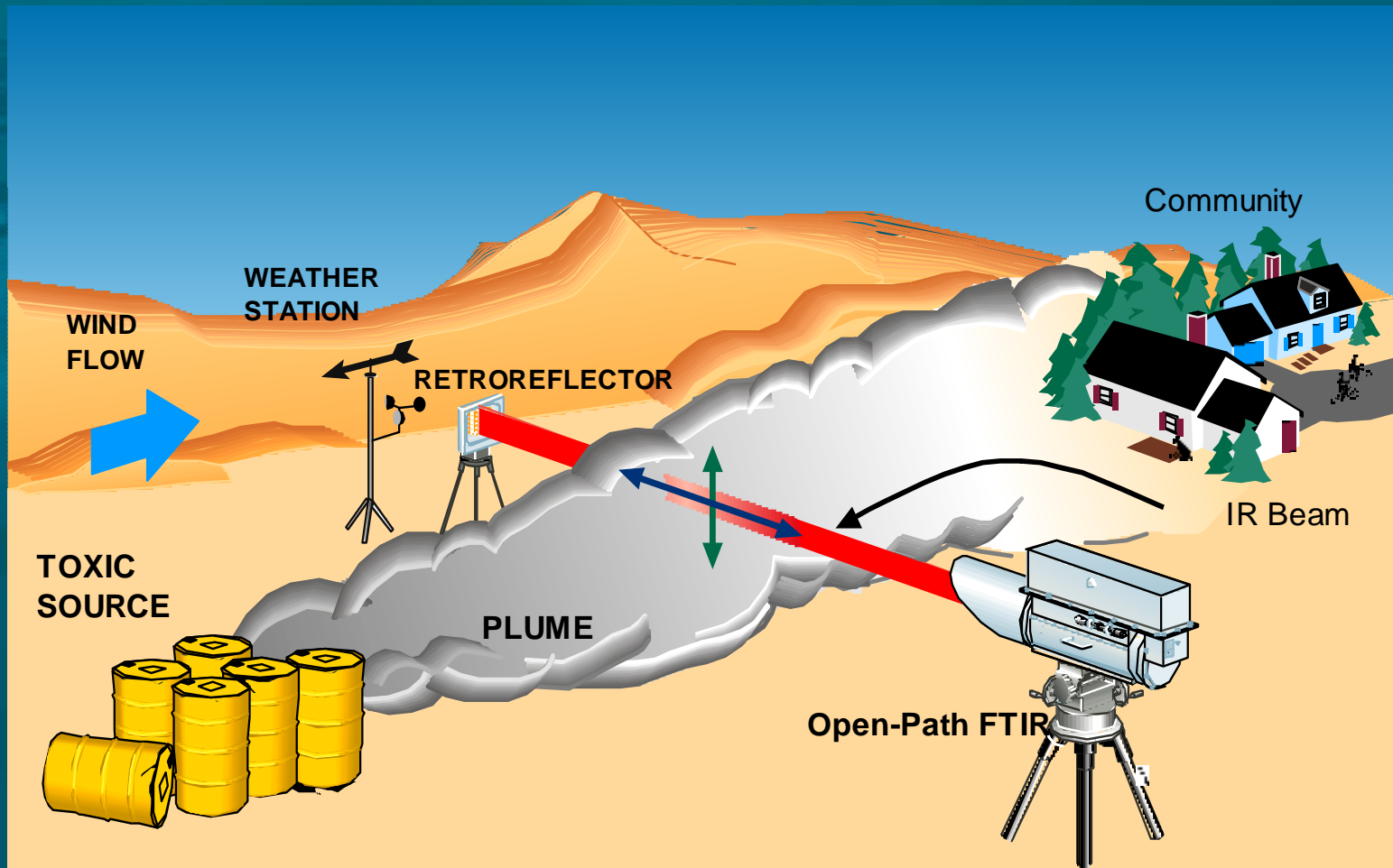
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Homeland Security: The Chemical Threat

- Chemical Warfare Agents (CWAs)
 - Threat: rogue nations and terrorist groups have been stockpiling Chemical Warfare Agents
- Toxic Industrial Chemicals (TICs)
 - Threat: terrorists could sabotage the present chemical infrastructure to produce large-scale exposure of the homeland community to Toxic Industrial Chemicals

OP-FTIR Measurement Configuration



FTIR Air-Measurement Technologies: Open-Path and Extractive

Technology

Both

Open-Path

Extractive

Advantage

Identify/Quantify most Chemicals
Real-Time

Large-scale continuous spatial coverage

- In-Situ
- Remote
- Tomography:
 - Source Characterization
 - Plume-Concentration Maps

Point Measurement at Vulnerable
Location (e.g. Air Intake of Buildings)

Monitoring at a Chemical Spill (Scotts Bluff R.R. Accident)

1.



2.

Wind Direction

R.R. Tracks

Spill

Samplers

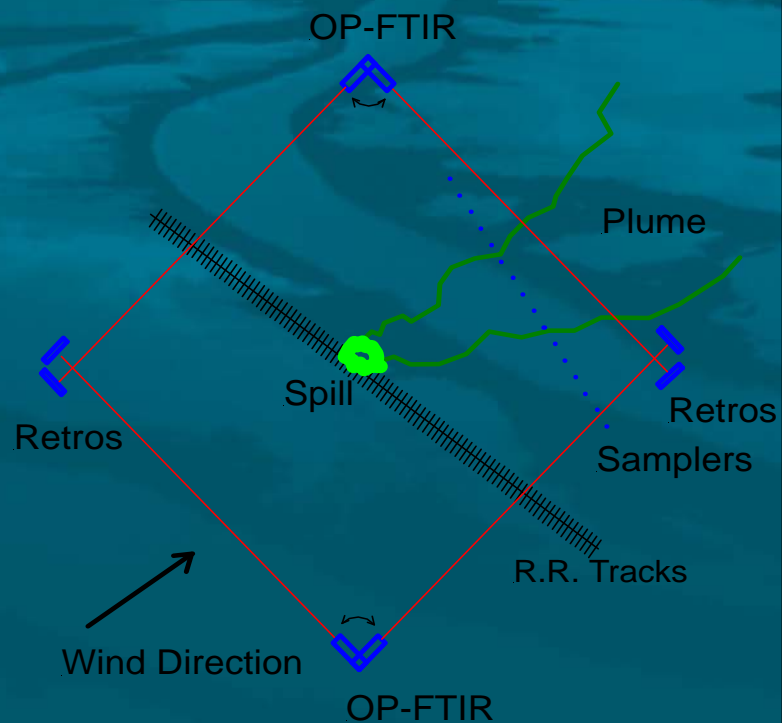
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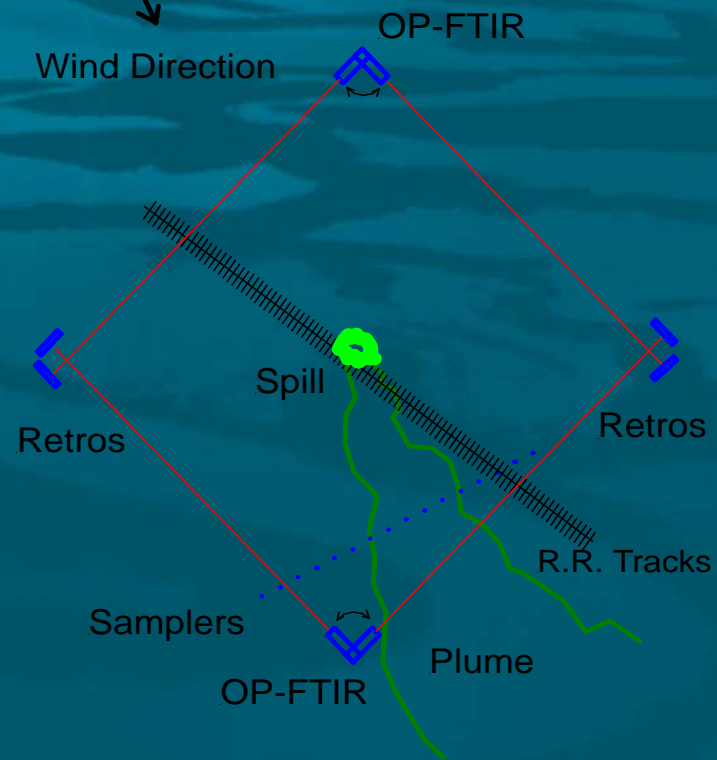


Tomographic Monitoring Scenario at Chemical Accident

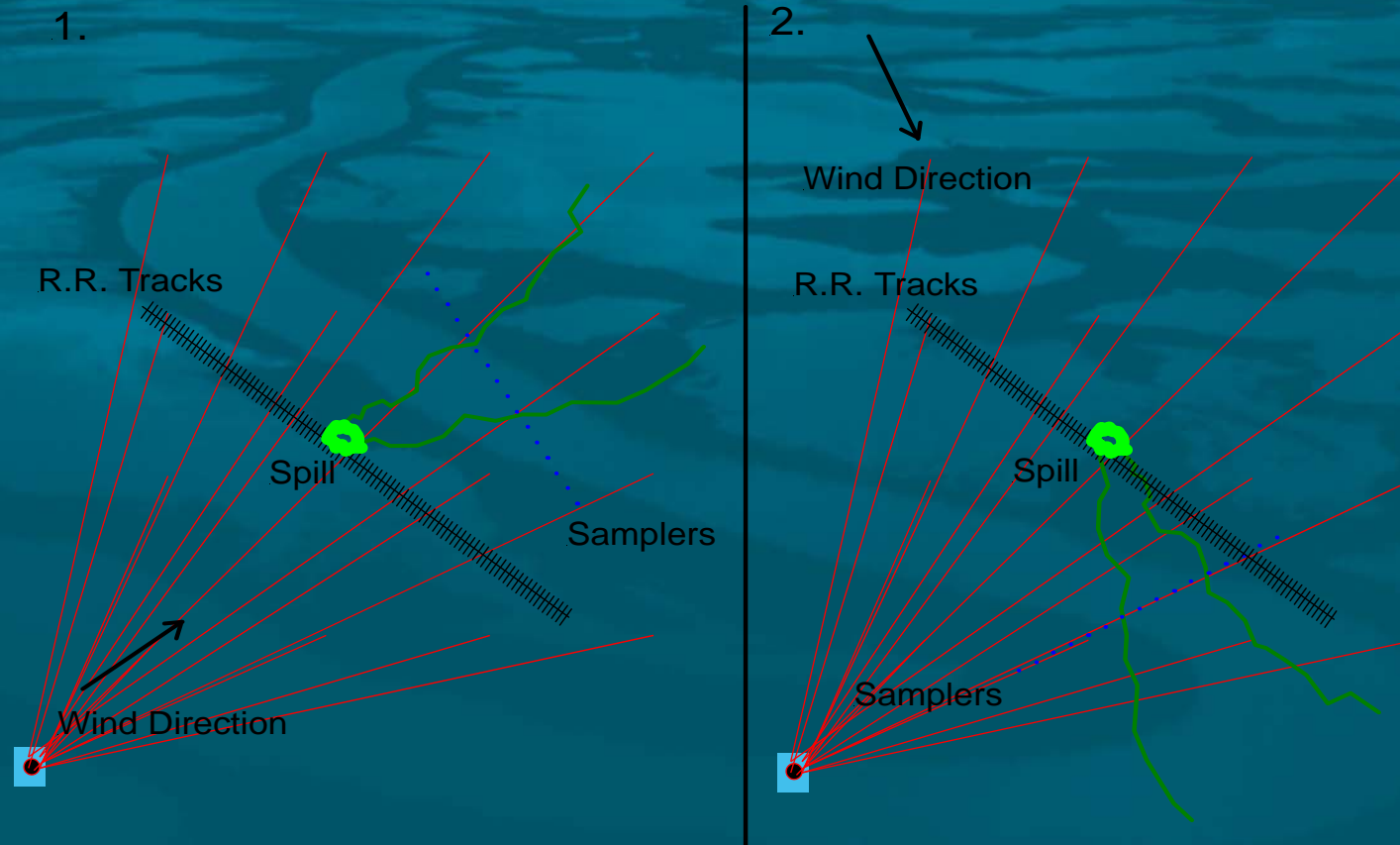
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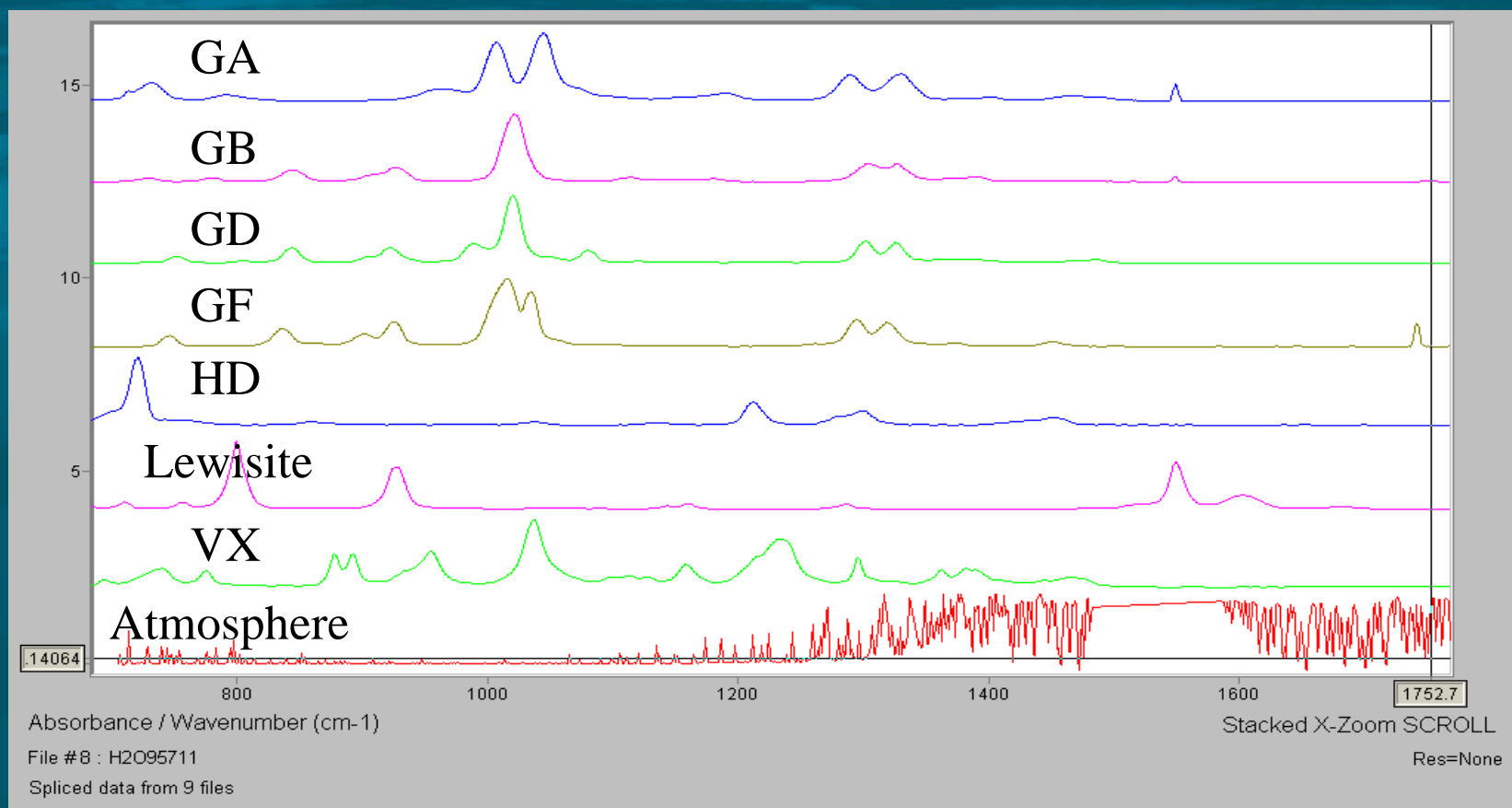


Tomographic Monitoring Scenario at Chemical Accident



IR Spectra of 7 CWAs

Open-Path FTIR

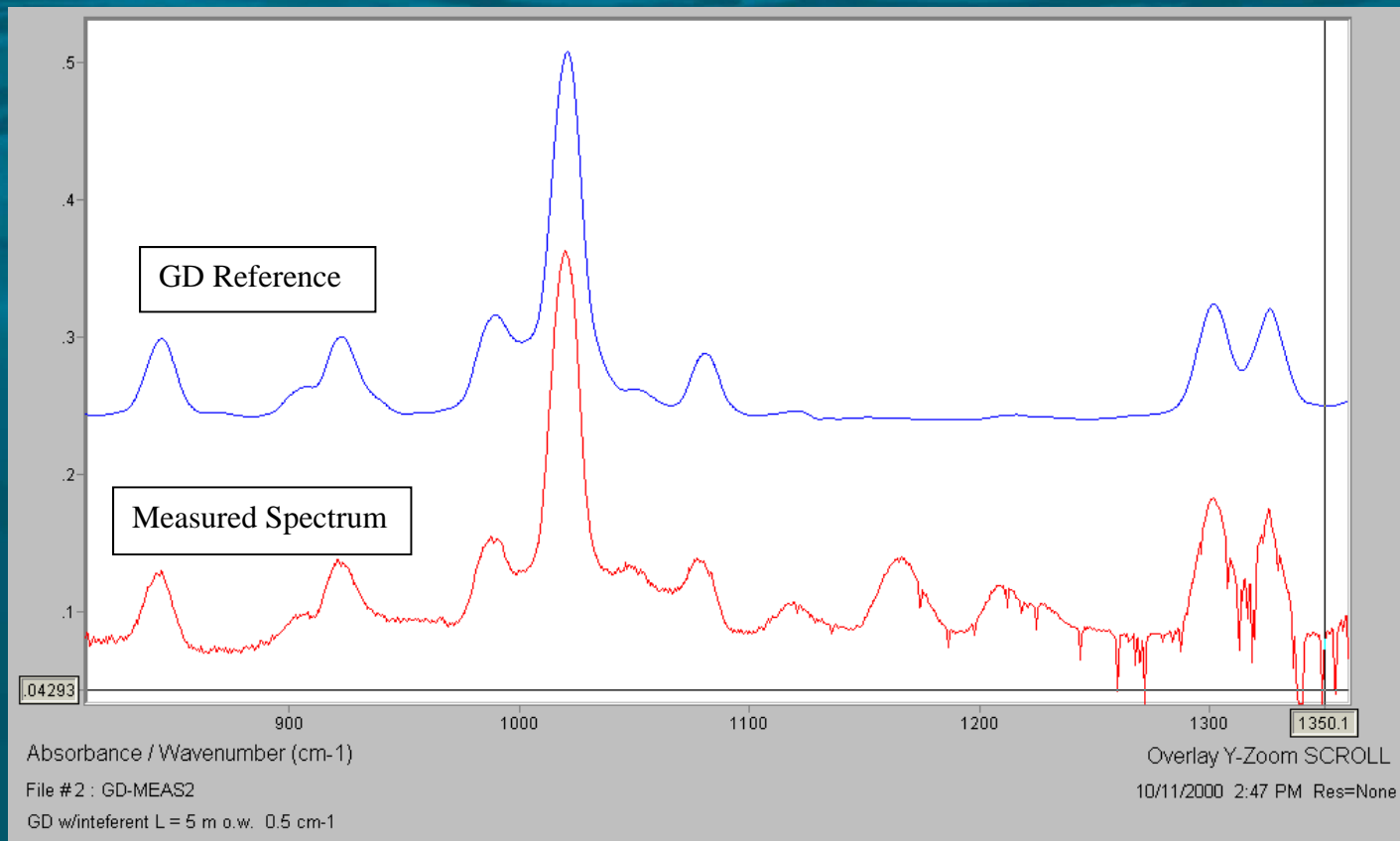


Open-Path FTIR Detection Limits for Chemical Warfare Agents

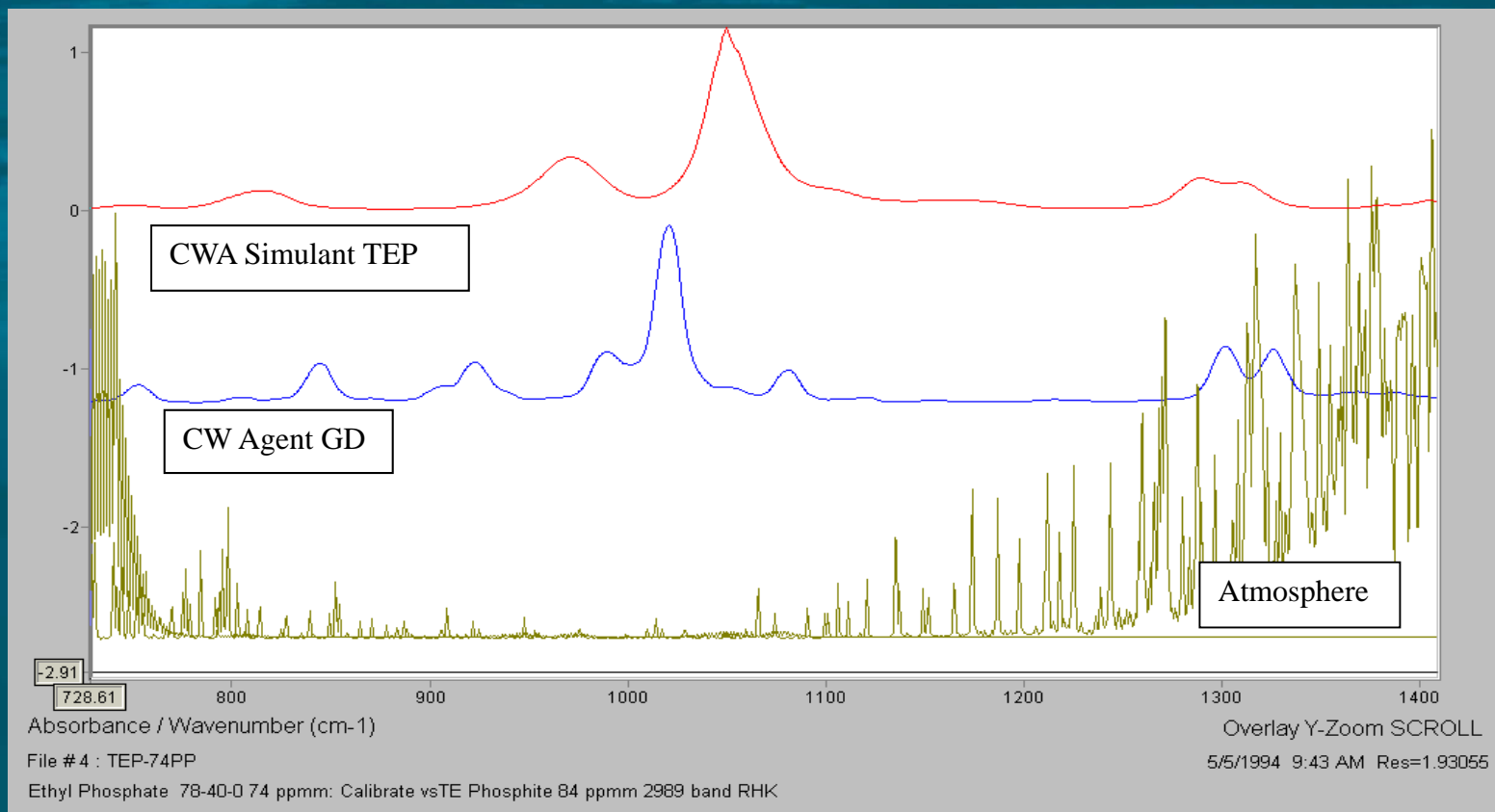
Chemical Agent	MDL (100 to 500 m) Meas. time = 2 sec	MDL (200 meters) Meas. time = 1 min
	(ppb)	(ppb)
GA	1.2	0.3
GB	0.7	0.2
GD	1.1	0.3
GF	0.9	0.2
HD 186	3	0.8
Lewisite	4	1.0
VX 22	16	4



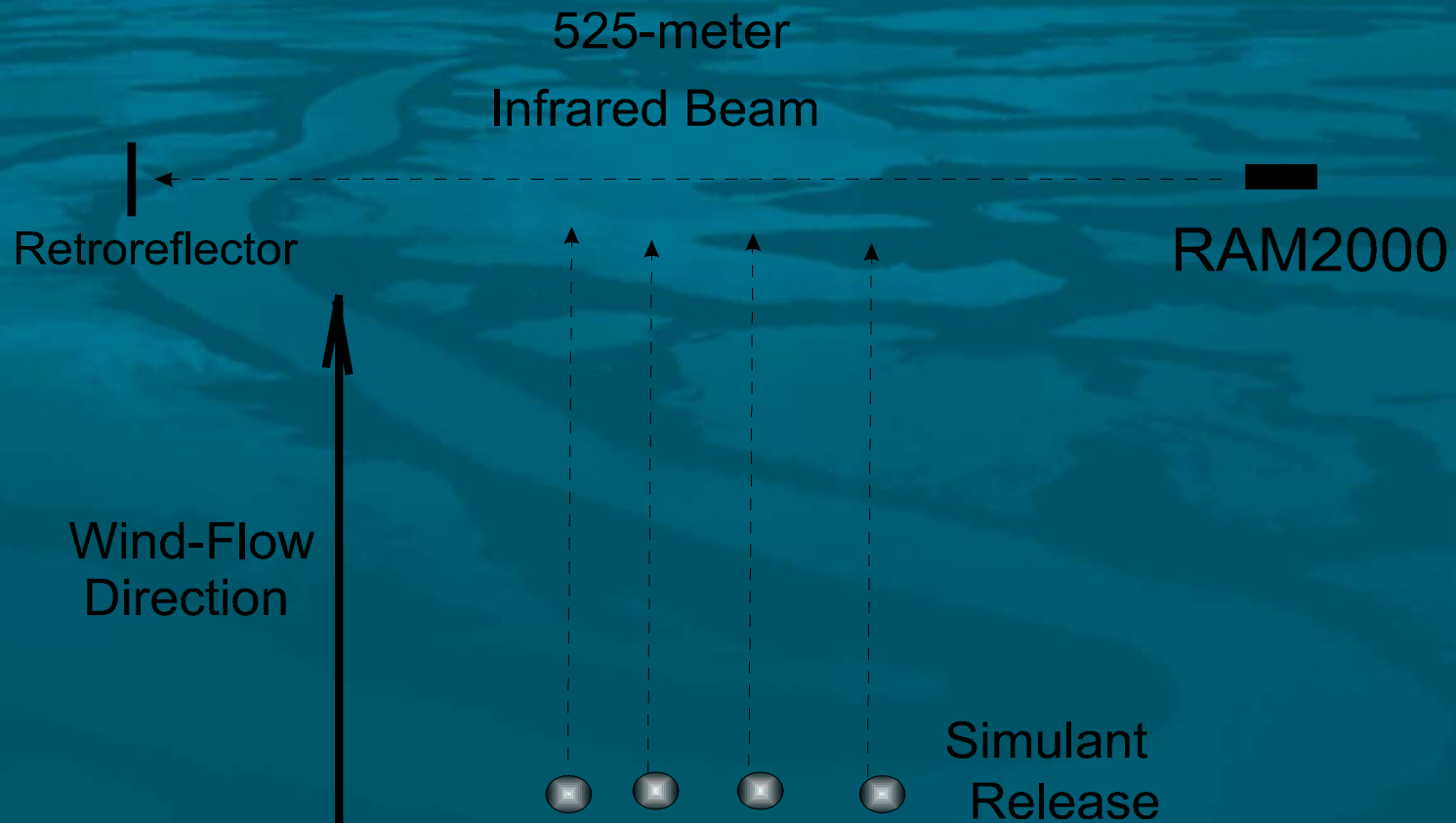
Comparison of Measured Spectrum to GD reference



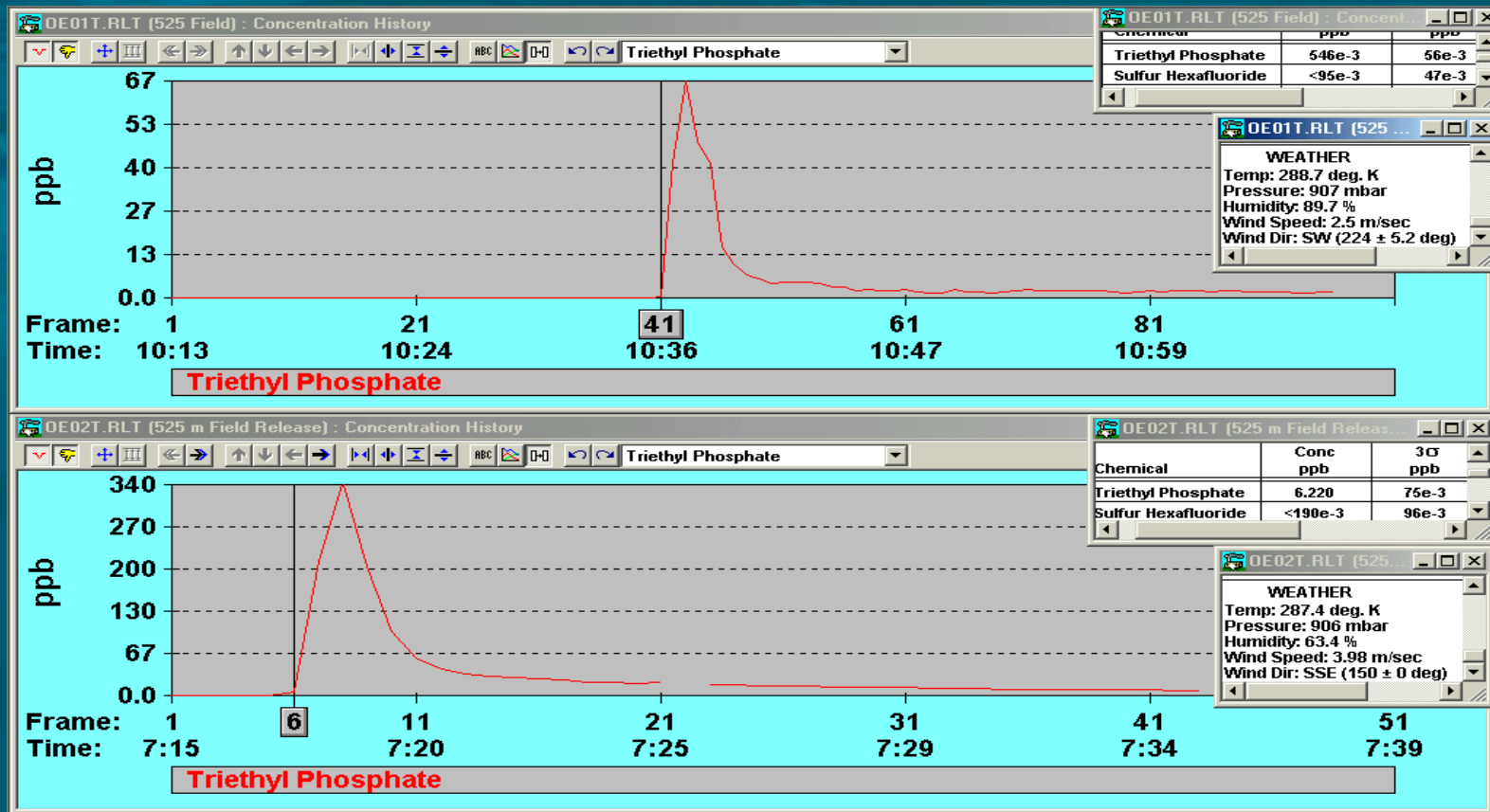
Comparison of IR Spectrum of Triethyl Phosphate to Agent GD



Field Release Configuration



Field Release of CWA Simulant Triethyl Phosphate



Open-Path FTIR Measurements of CWA-Simulant Field Releases

Run Number	Chemical	First Detection (ppb)	Maximum Level (ppb)
Release1	Triethyl Phosphate	0.55 ± 0.06	66.65 ± 1.0
Release 2	Triethyl Phosphate	6.220 ± 0.08	336.2 ± 7.1
Release 3	Sulfur Hexafluoride	3.71 ± 0.12	1230.2 ± 5.3
Release 4	Sulfur Hexafluoride	9.88 ± 0.20	905.4 ± 0.1

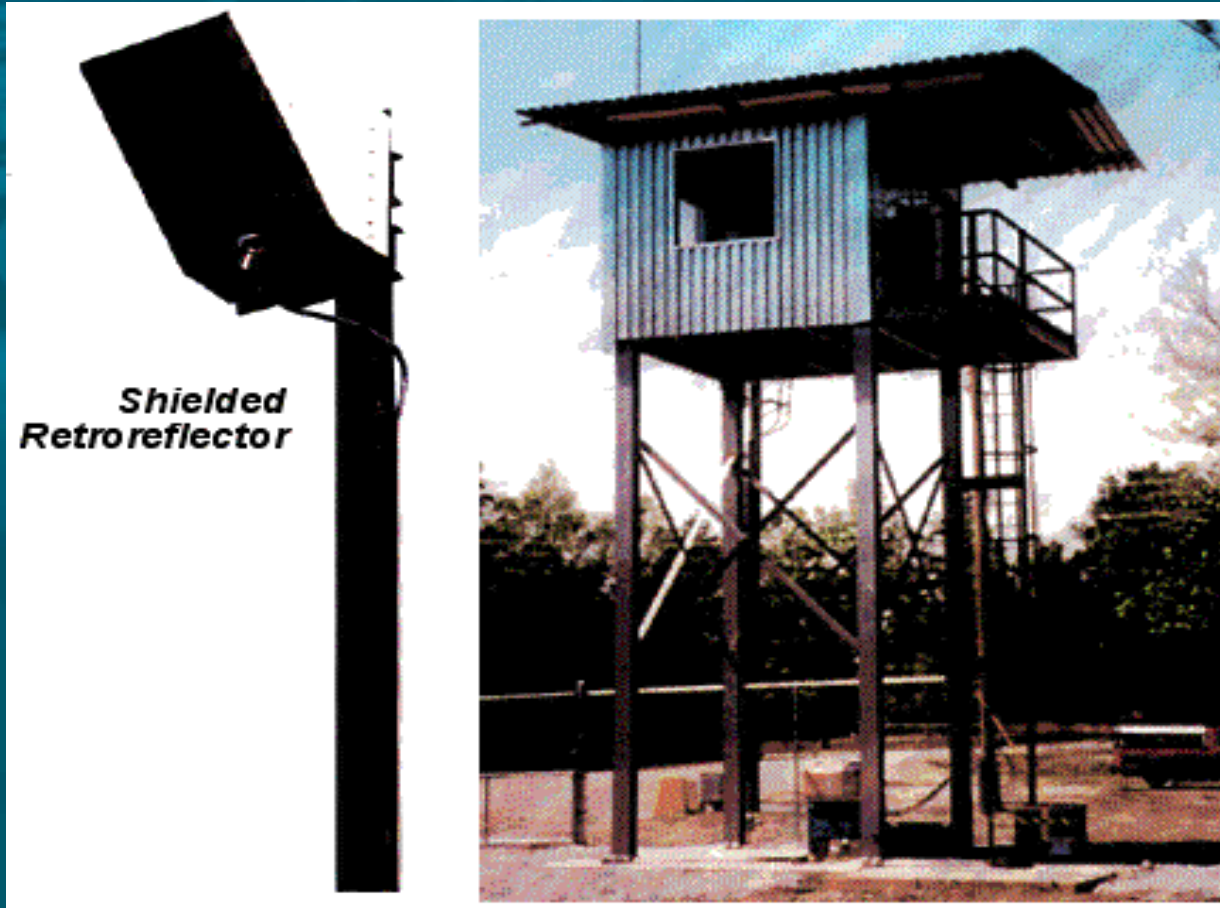
Open-Path FTIR Defense Applications

- Remediation Monitor – Emergency Response
 - Chem Decom
 - Facility Closures
- Chemical Agent Stockpile Monitor
 - Safety
- Military Facility Perimeter Monitors
 - Protection against chemical attack
- Ground Truth for field testing chemical monitors

Fenceline Coverage of Chemical Facility in New York State



Open-Path Fenceline Installation in South Carolina Facility



Conclusion

Open Path FTIR:

- Ability to Monitor a Large Number of Chemicals in Real-Time
- Valuable Component of an Early Warning Response System to Chemical Attacks and Accidents
- Hazardous Levels of CWAs and TICs can be Reported in Seconds
- Continuously Monitor the Perimeter of Potential Targets for Release of CWAs and TICs
- Combine with Tomography
 - Locate Emission Sources
 - Determine Plume-Transport Direction For Community Evacuation Decisions



Proposed Perimeter Monitor at a Potential Chemical Target



Concentration-Rose Points to Emission Source

