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



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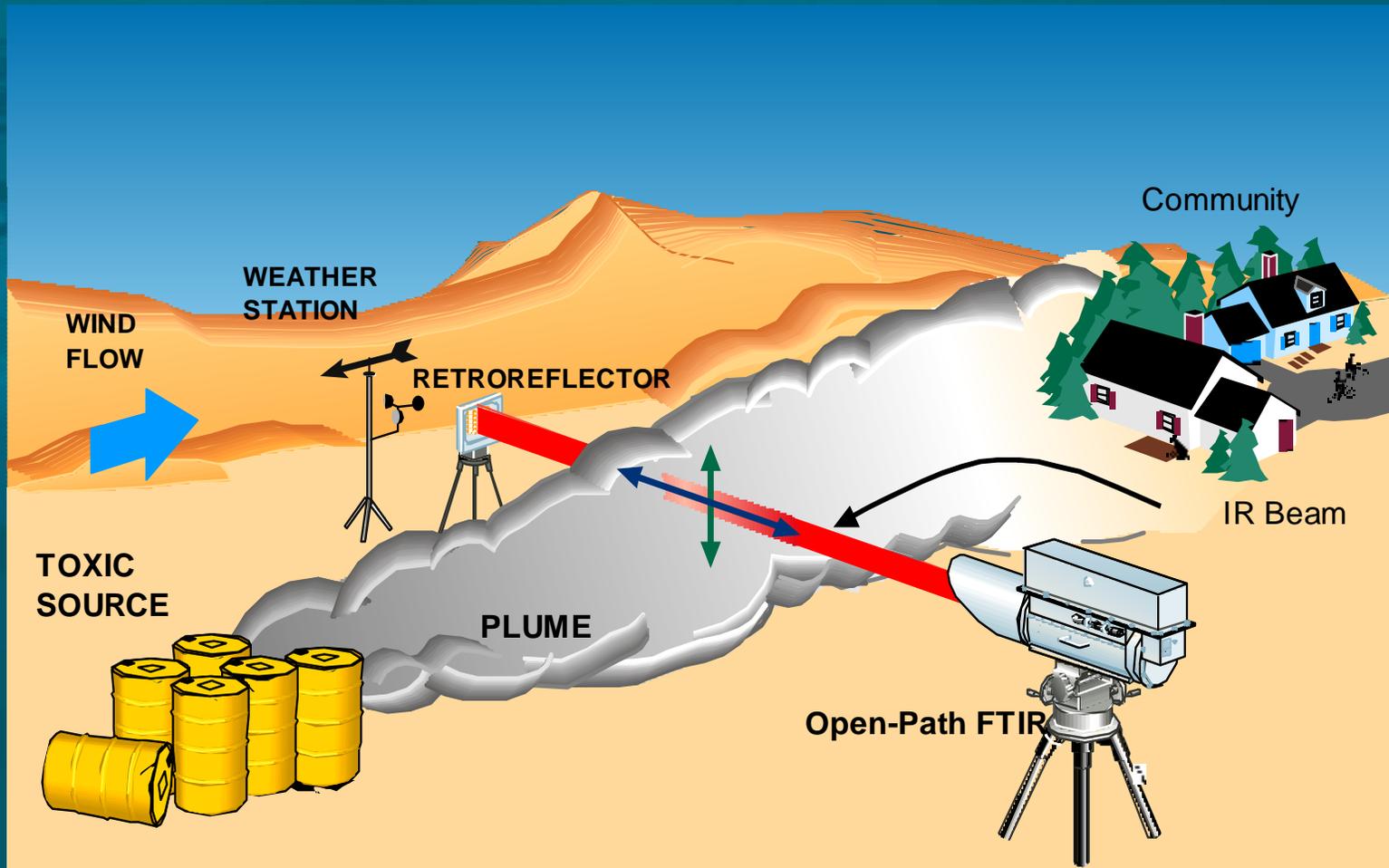


Homeland Security: The Chemical Threat

- 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

Advantage

Both

Identify/Quantify most Chemicals
Real-Time

Open-Path

Large-scale continuous spatial coverage

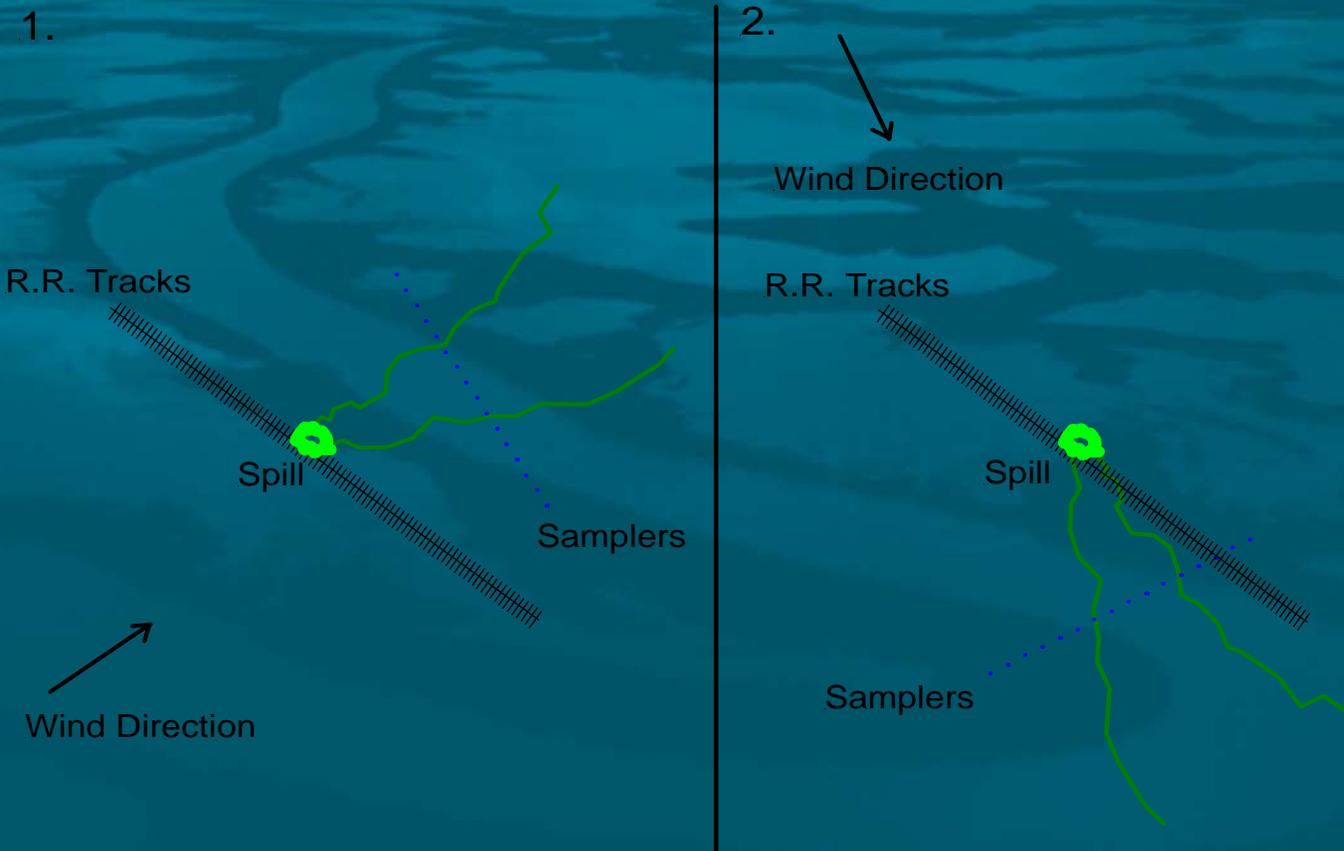
- In-Situ
- Remote
- Tomography:
 - Source Characterization
 - Plume-Concentration Maps

Extractive

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

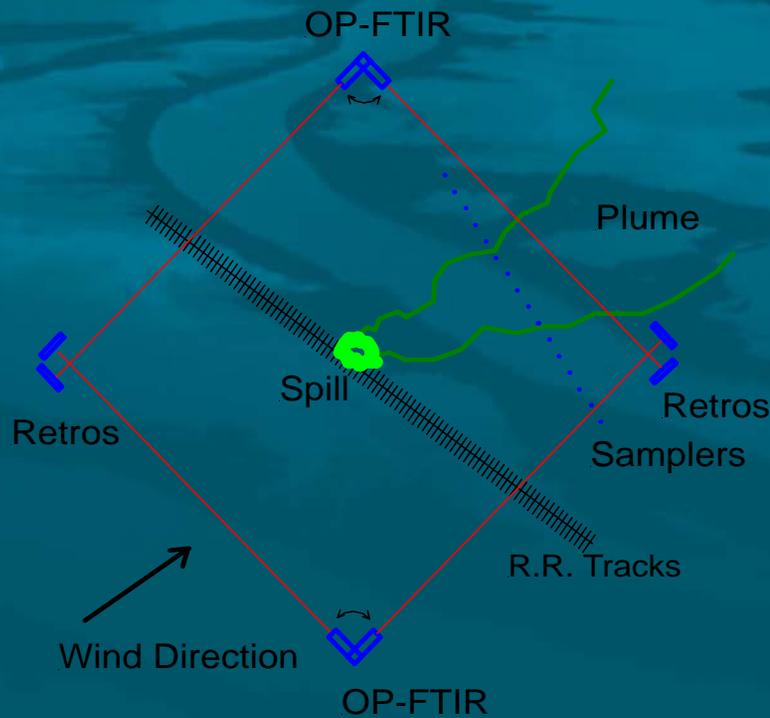


Monitoring at a Chemical Spill (Scotts Bluff R.R. Accident)

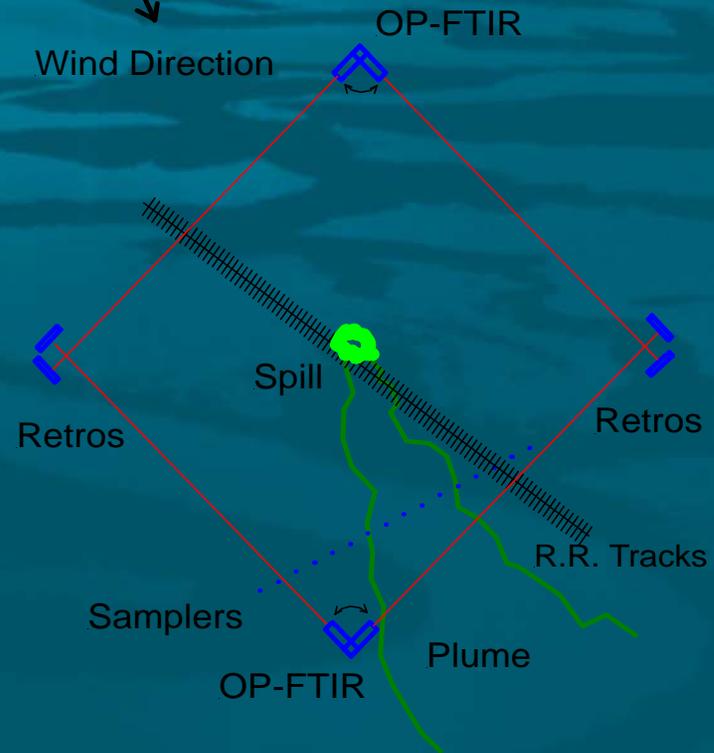


Tomographic Monitoring Scenario at Chemical Accident

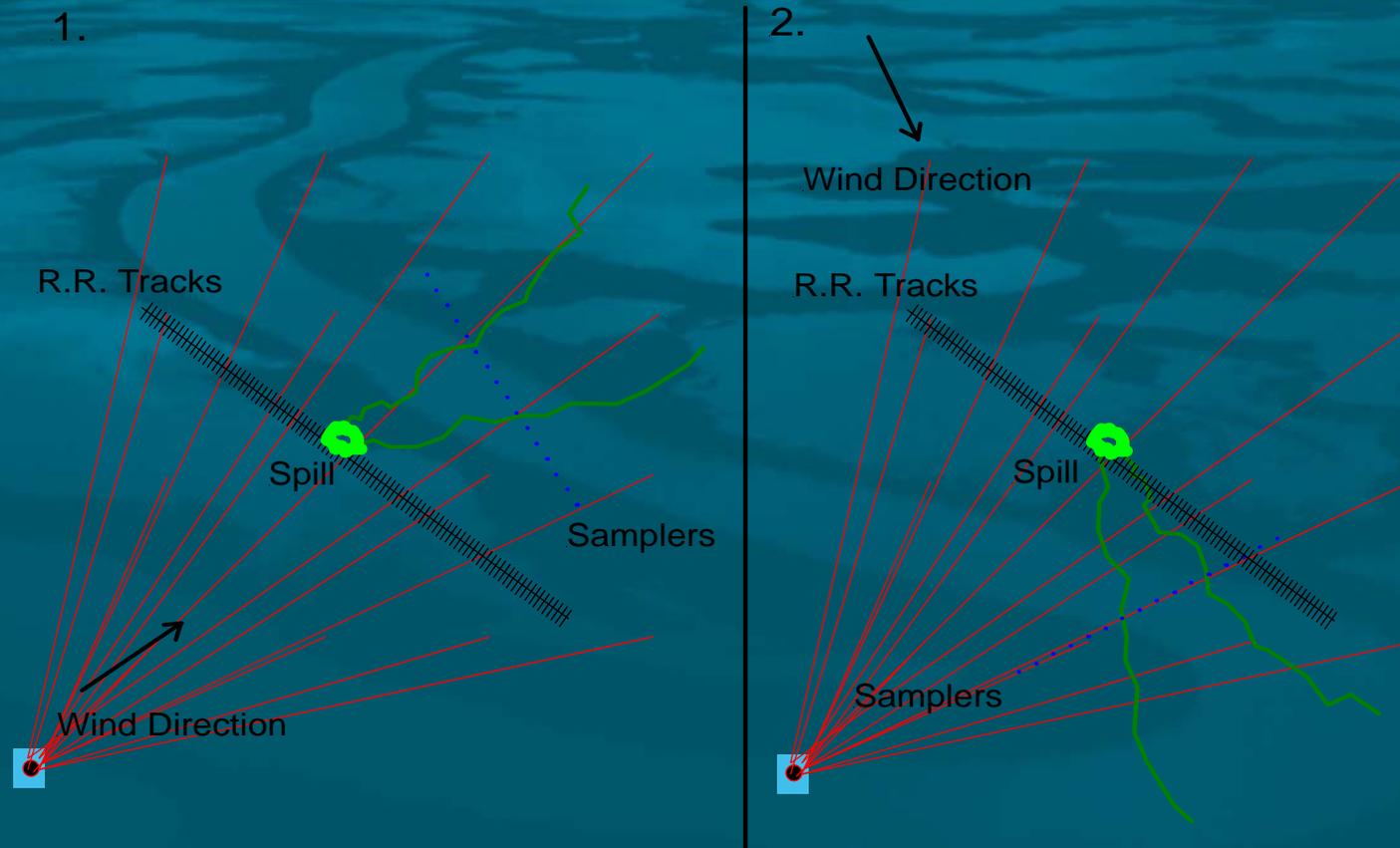
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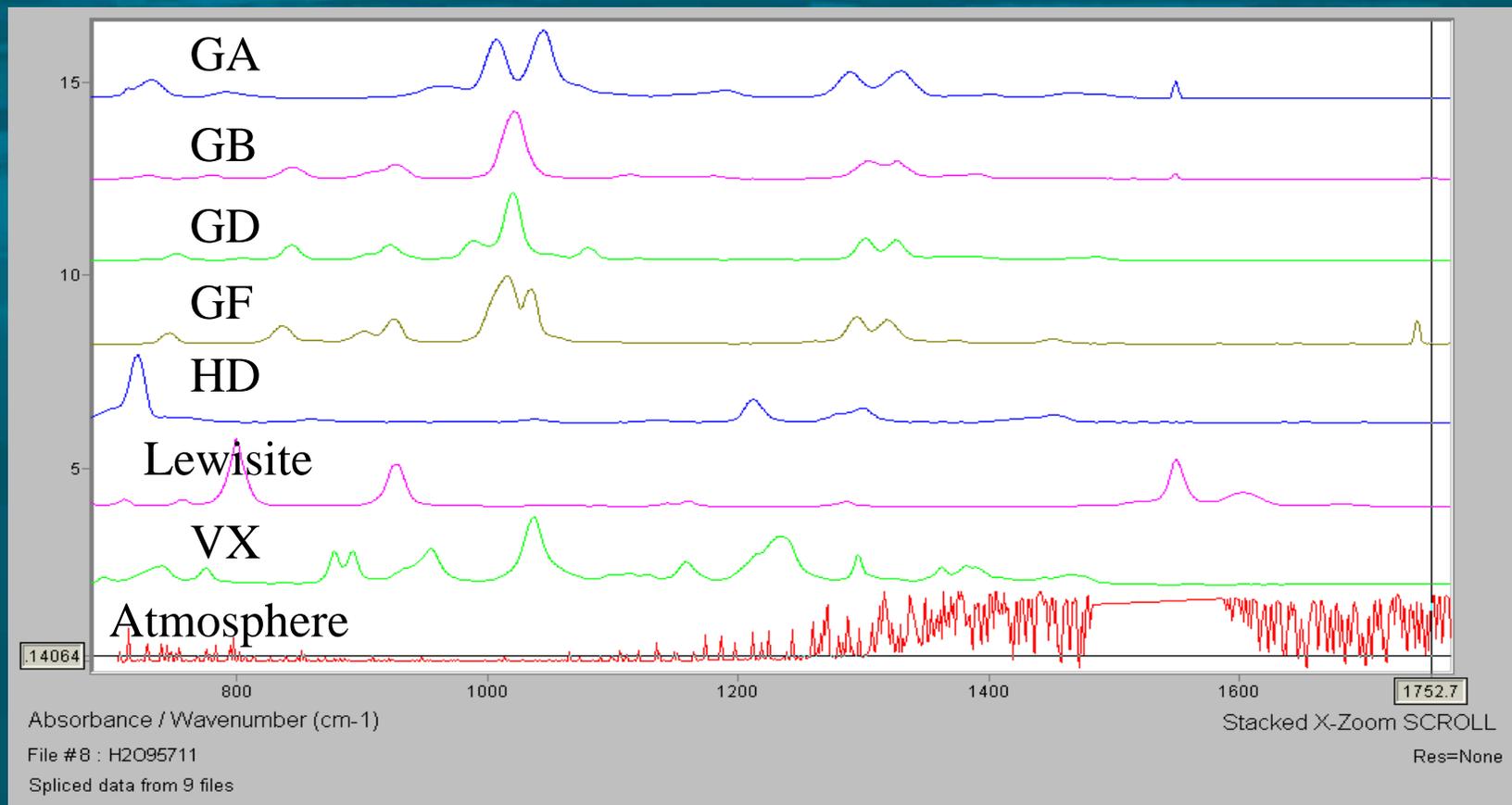


Tomographic Monitoring Scenario at Chemical Accident



IR Spectra of 7 CWAs

Open-Path FTIR

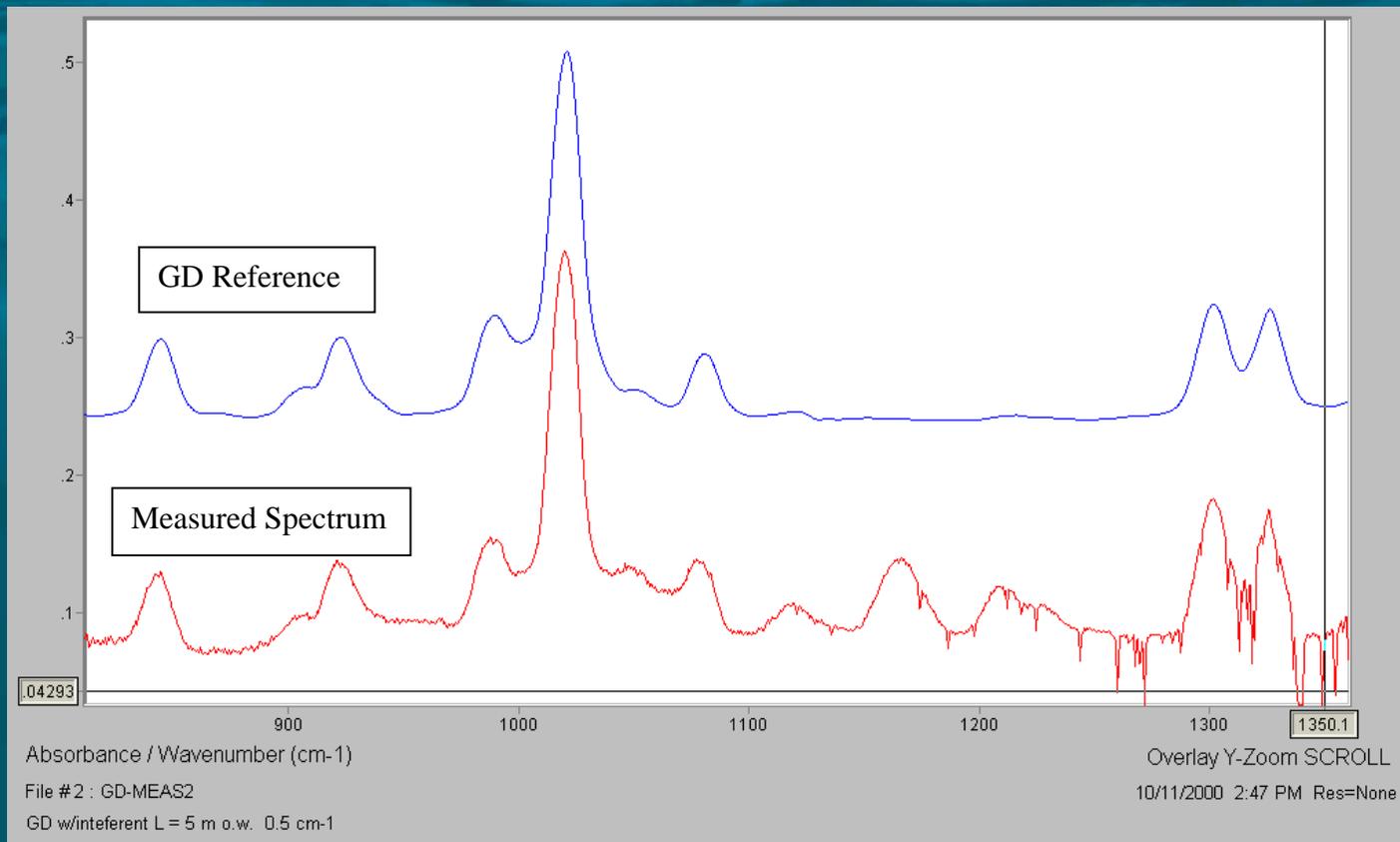


Open-Path FTIR Detection Limits for Chemical Warfare Agents

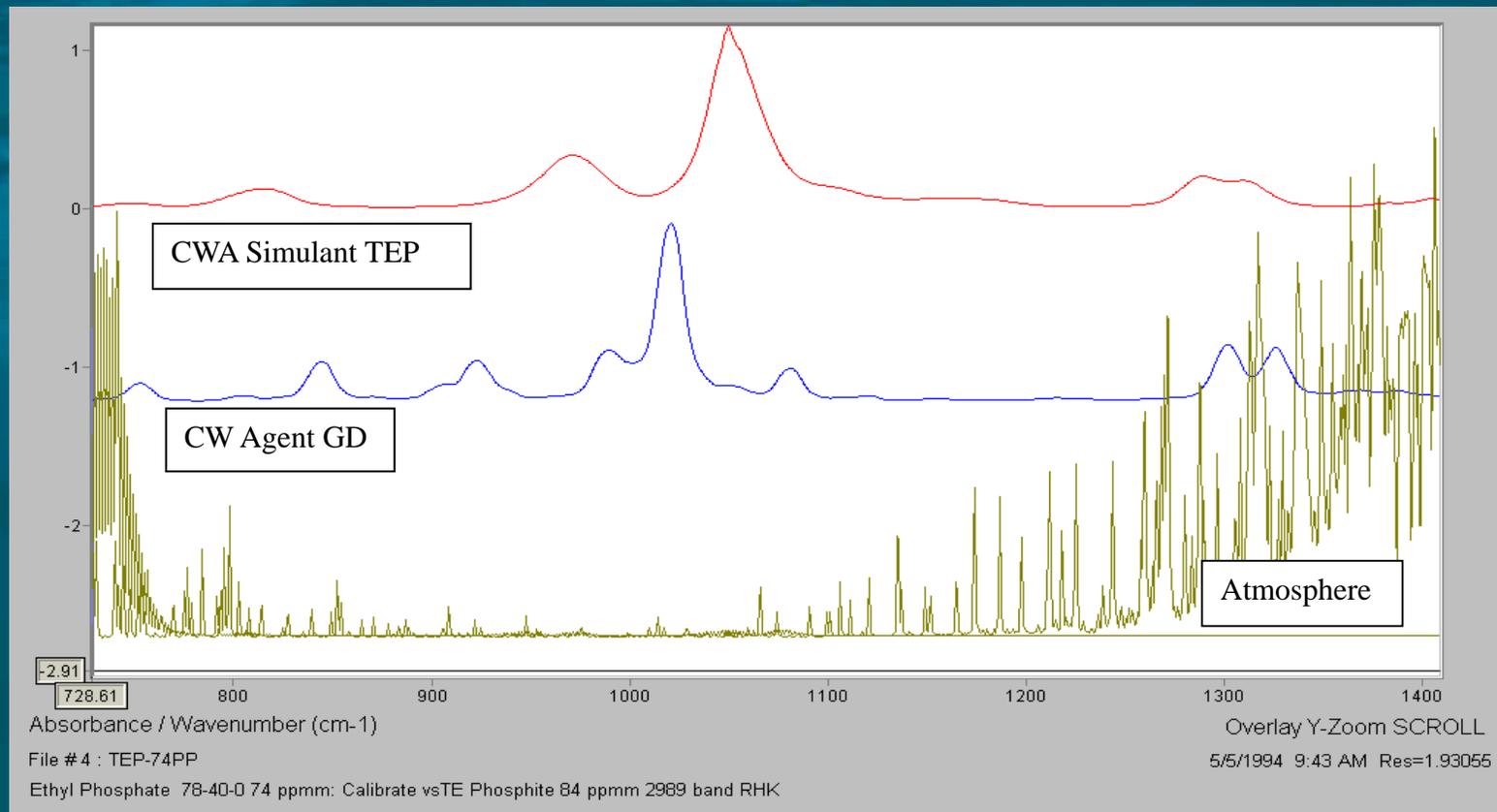
| Chemical Agent | MDL (100 to 500 m) Meas. time = 2 sec | MDL (200 meters) Meas. time = 1 min |
|----------------|---|---|
| | (ppb) | (ppb) |
| GA | 1.2 | 0.3 |
| GB | 0.7 | 0.2 |
| GD | 1.1 | 0.3 |
| GF | 0.9 | 0.2 |
| HD 186 | 3 | 0.8 |
| Lewisite | 4 | 1.0 |
| VX 22 | 16 | 4 |



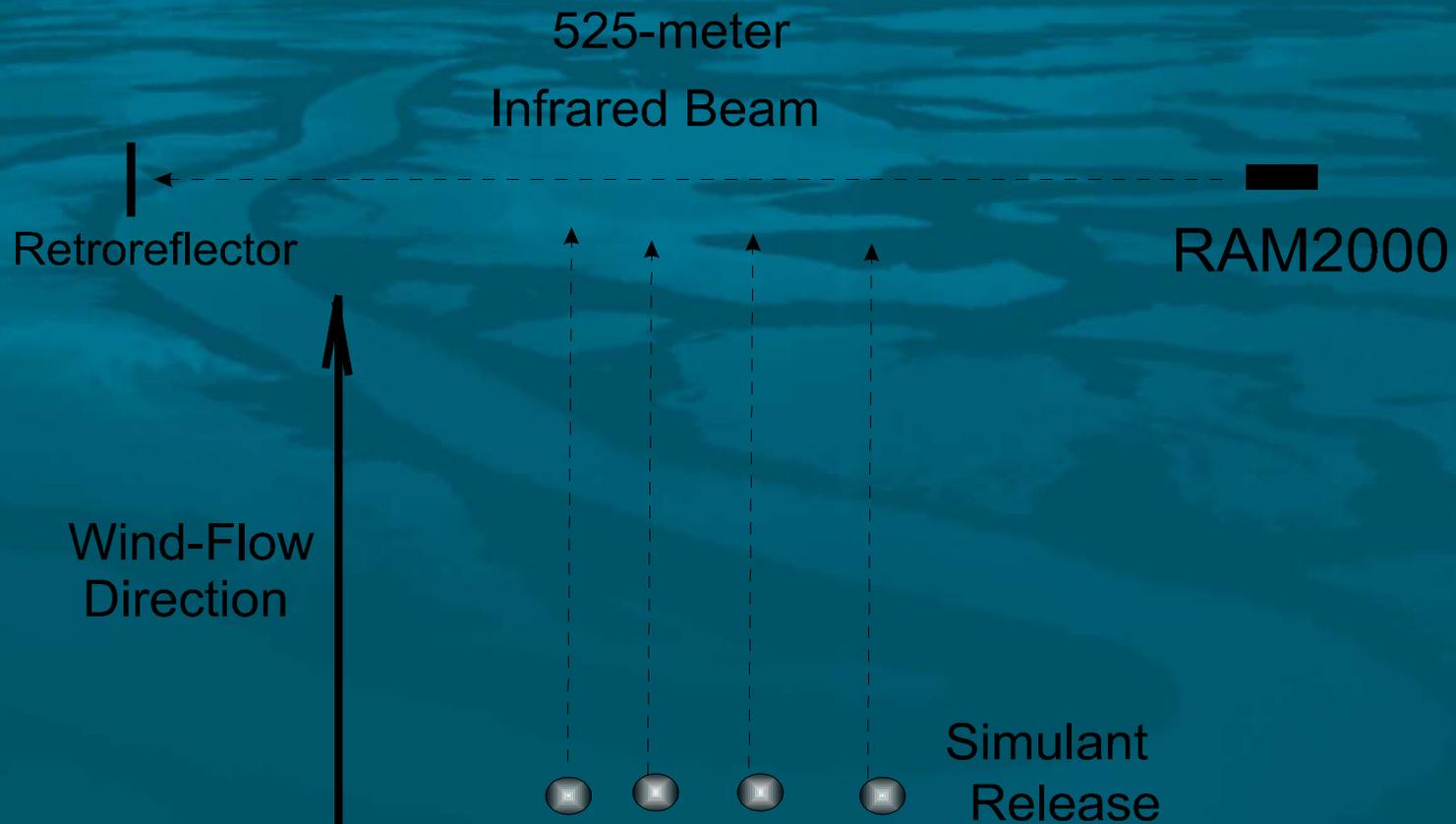
Comparison of Measured Spectrum to GD reference



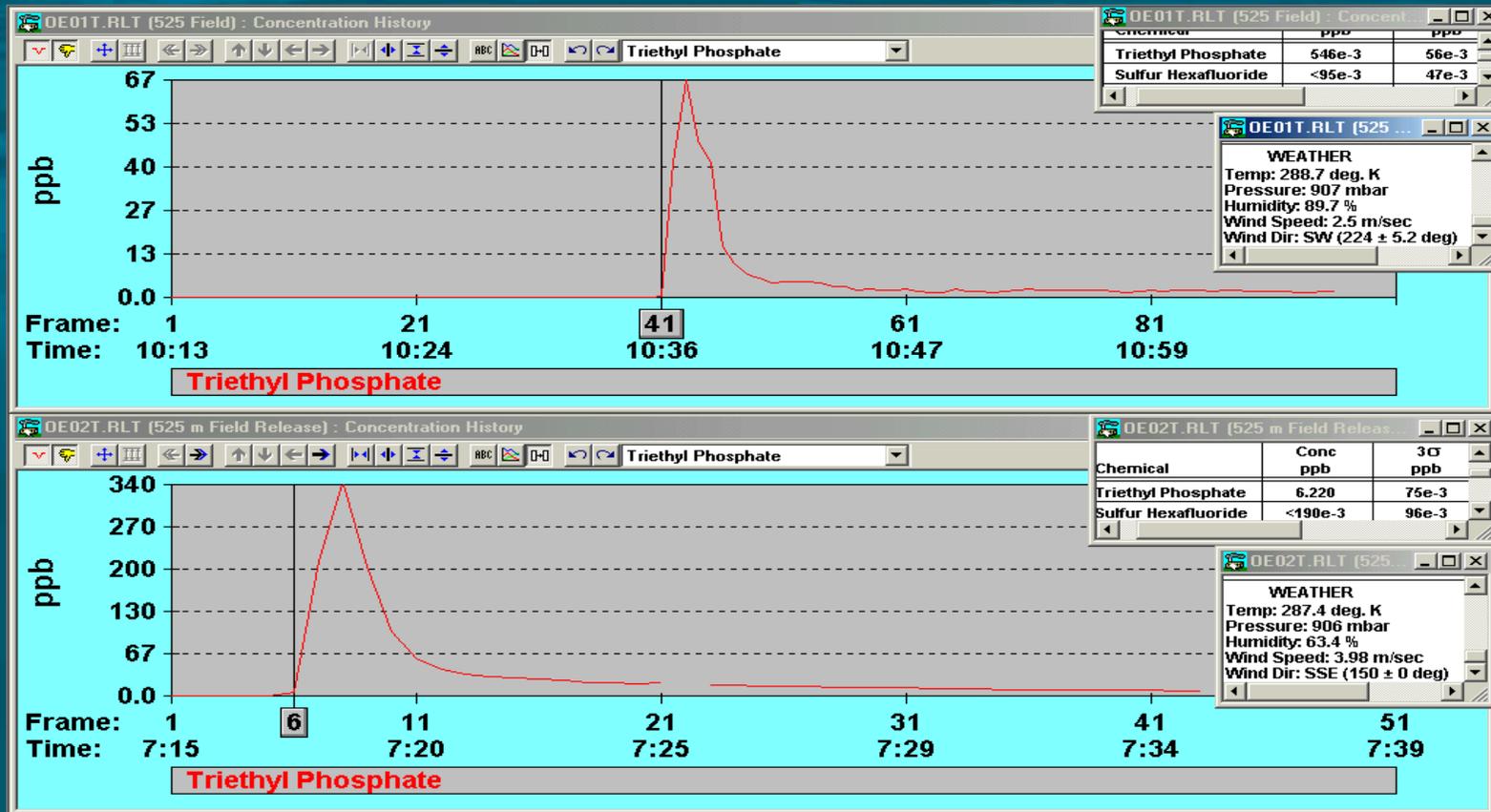
Comparison of IR Spectrum of Triethyl Phosphate to Agent GD



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) |
|------------|---------------------|-----------------------|---------------------|
| Release 1 | 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

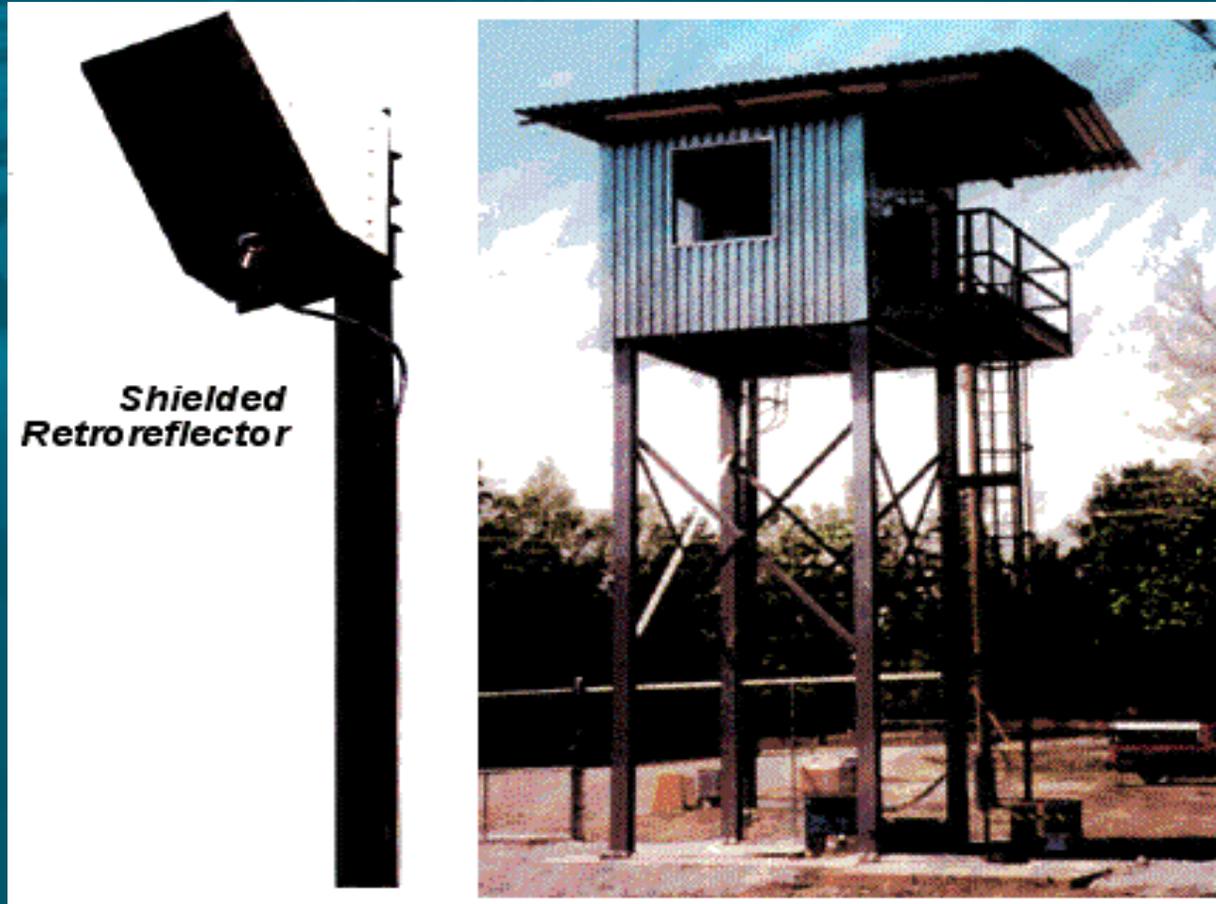
- Remediation Monitor – Emergency Response
 - Chem Decom
 - Facility Closures
- Chemical Agent Stockpile Monitor
 - Safety
- Military Facility Perimeter Monitors
 - Protection against chemical attack
- Ground Truth for field testing chemical monitors



Fenceline Coverage of Chemical Facility in New York State



Open-Path Fenceline Installation in South Carolina Facility



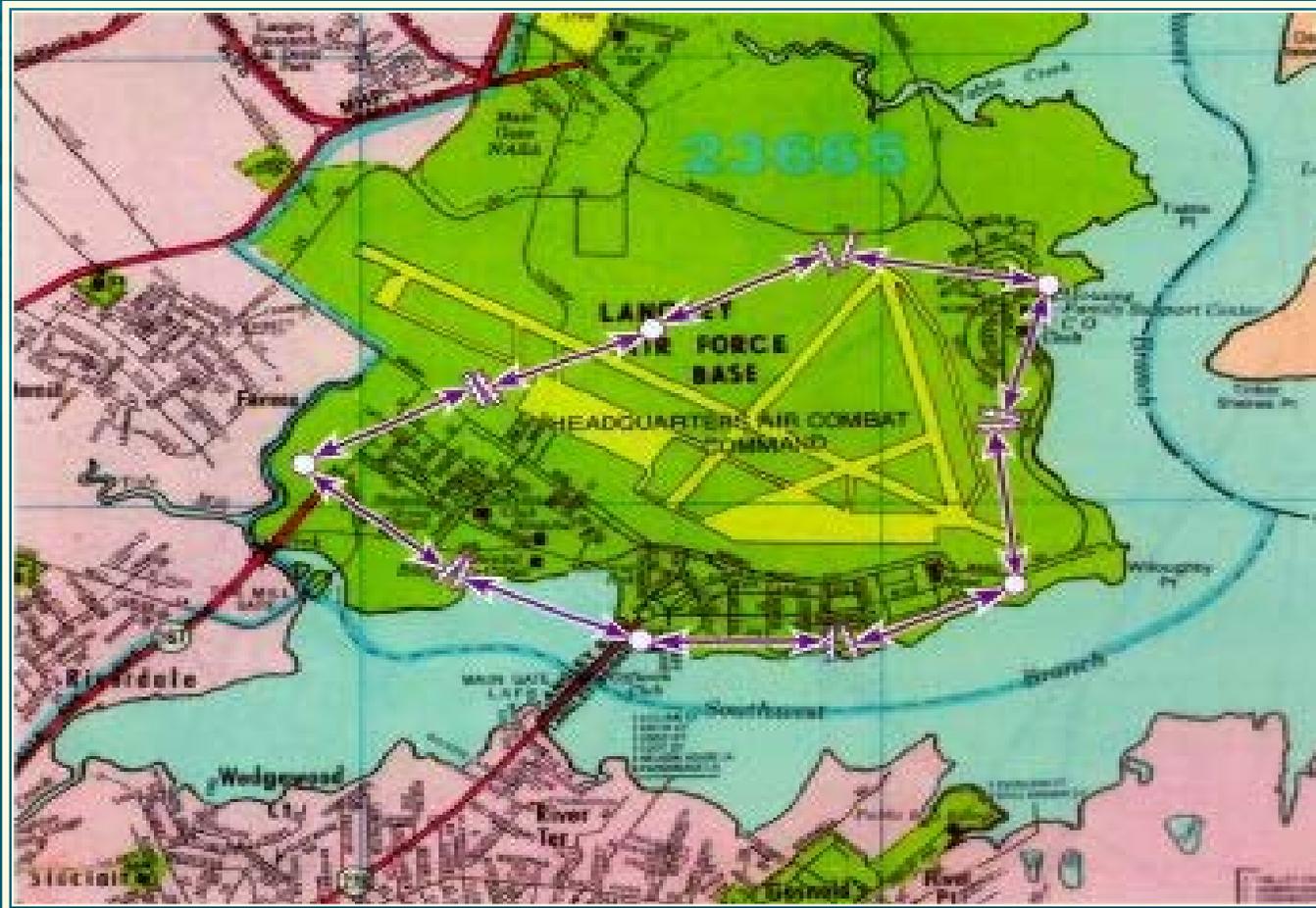
Conclusion

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

