
Facility Defense Against Aerosol Attack

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3 April 2002

MS-15434

This work was sponsored under Air Force contract F19628-00-C-0002. The views expressed are those of the Author and do not reflect official policy or position of the United States Government.

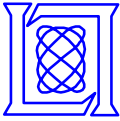
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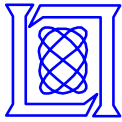
Report Documentation Page

Report Date 03APR2002	Report Type N/A	Dates Covered (from... to) 03APR2002 - 04APR2002
Title and Subtitle Facility Defense Against Aerosol Attack	Contract Number F19628-00-C-0002	
	Grant Number	
	Program Element Number	
Author(s) Cousins, Dan	Project Number	
	Task Number	
	Work Unit Number	
Performing Organization Name(s) and Address(es) MIT Lincoln Laboratory	Performing Organization Report Number	
Sponsoring/Monitoring Agency Name(s) and Address(es) Air Force ESC/XPK (Richard Axtell) Hanscom AFB, MA 01731	Sponsor/Monitor's Acronym(s)	
	Sponsor/Monitor's Report Number(s)	
Distribution/Availability Statement Approved for public release, distribution unlimited		
Supplementary Notes Workshop paper from the New England Bioterrorism Preparedness Workshop held 3-4 april 2002 at MIT Lincoln Laboratory, Lexington, MA, The original document contains color images.		
Abstract		
Subject Terms		
Report Classification unclassified	Classification of this page unclassified	
Classification of Abstract unclassified	Limitation of Abstract SAR	
Number of Pages 19		



Outline

- **Facilities and attack scenarios**
- **Sensing an attack**
- **Facility protection techniques**

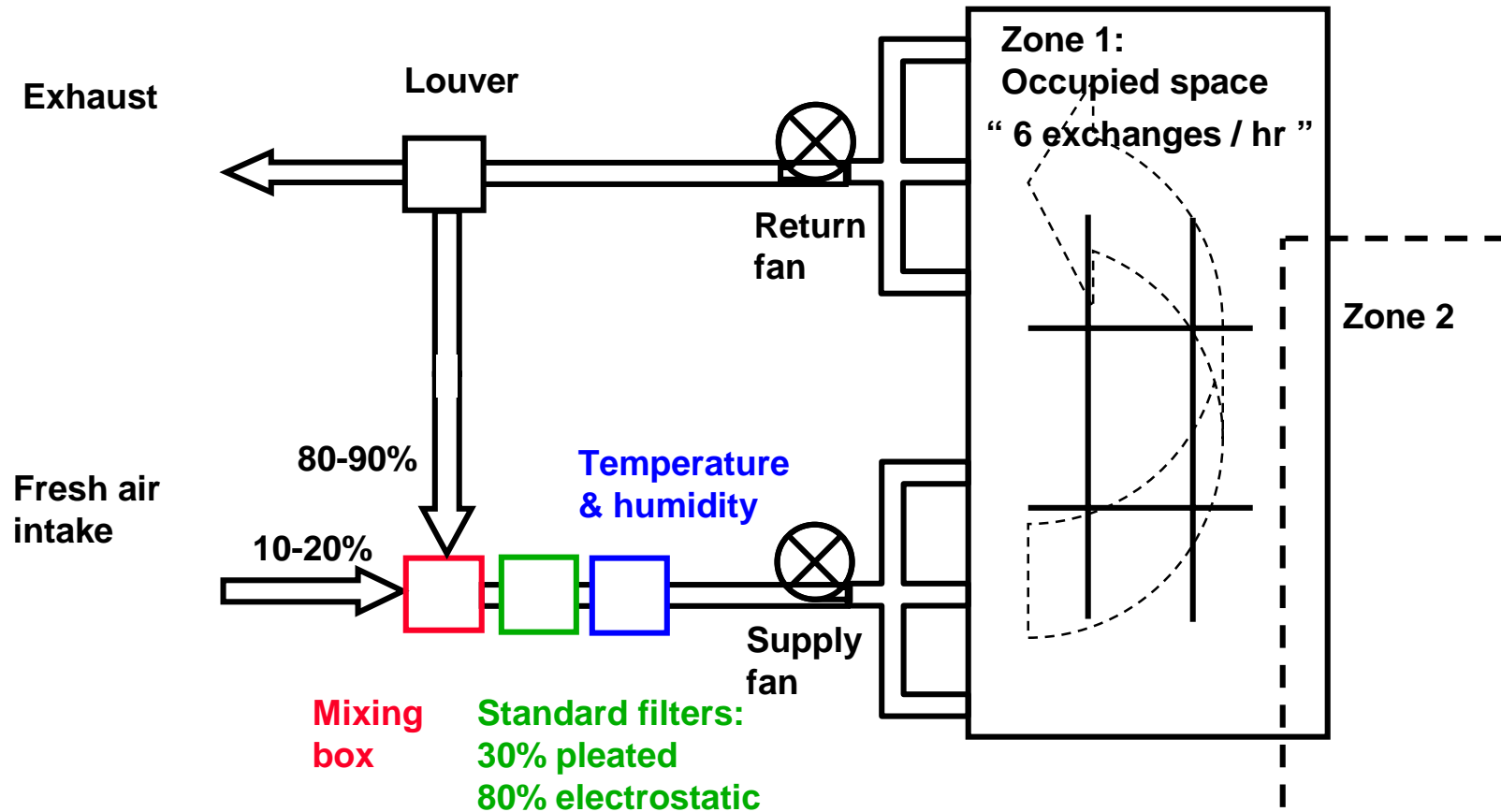


Types of facilities

- **Simple structures**
 - Residences, barracks
- **Buildings with ventilation system**
 - **Multiroom office building**
 - Large open space (arena, terminal, ...)
- **Subway**
- **Outdoor sites**
 - Stadium
 - Public gathering
 - Military operations



Simplified Ventilating System





Types of Attacks

- **External attacks**
 - Nearby cloud release
 - Burst release into air intake
- **Internal attacks**
 - Burst release into air return
 - Burst release into a large open space
 - Low level continuous release
- **Small amounts of agent are substantial threats**

1 gram bioagent uniformly dispersed into 10^8 liter building (100m x 100m x 10m);

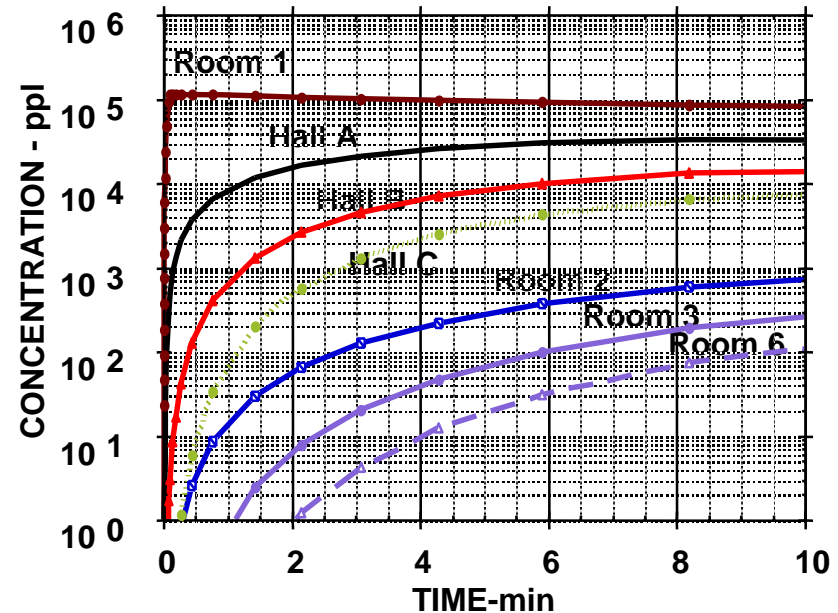
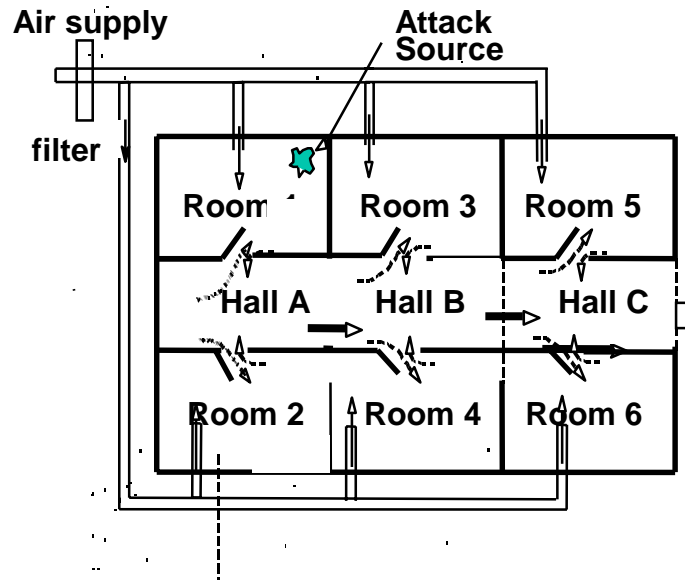
Corresponds to lethal exposure (100 ppl x 10 liter/min x 10 min; 10^{10} particles /gram)



Modeling an Attack

Burst release in an interior room

- Bioagent - 15 grams over 5 sec
- Room-Hall coupling - 10%



- Lumped parameter models are well established
instantaneous and uniform concentration within each room
- Initial particle dispersal and deposition are more complicated to model.



Emergency Management Measures

- **Information**

- **Observing suspicious activity**
- **Knowing who to treat**
 - › **Primarily, but not exclusively, bio agents**
 - › **Records of access (badge swipes, tickets,...)**
 - › **Voluntary response to public announcement**
 - › **Physical examination**
- **Preserving forensic evidence**

- **Plan of action**

- **HVAC emergency management decision tree**
 - › **Suspicious event near air intake -> shut down intake**
 - › **Suspicious event inside building -> full fresh air**
- **Communication channels**
- **Evacuation plan**
 - › **Orderly movement to controlled safe area, avoid cross contamination**



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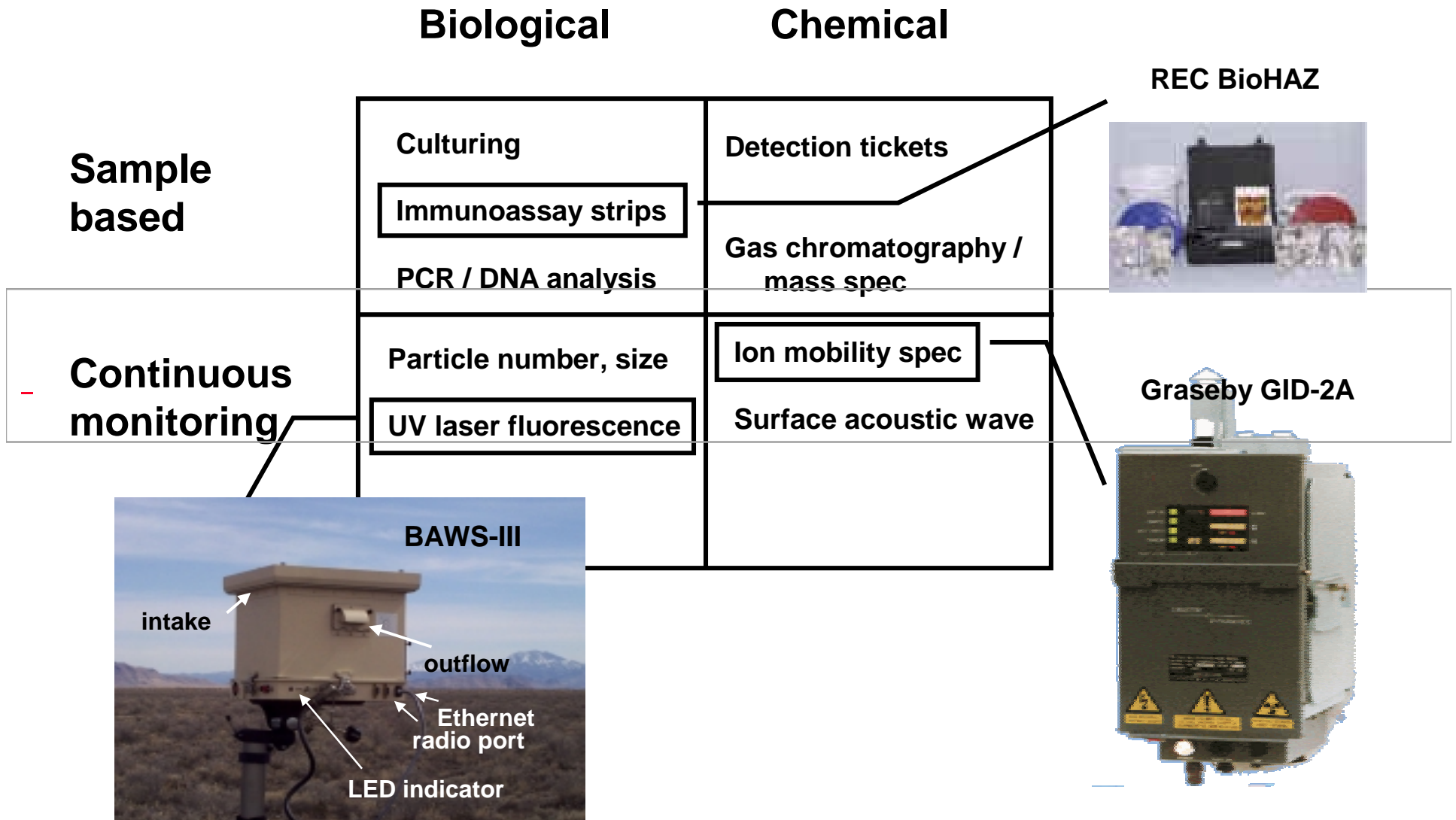


Rationale for Sensing

- **Issue alarm**
 - initiate facility response
 - high $\text{Prob}_{\text{detection}}$; low $\text{Prob}_{\text{false alarm}}$; wide range of agents
- **Identification of agent**
 - initiate medical treatment
- **Mapping of contamination zone**
- **Assessing decontamination (“all-clear”)**

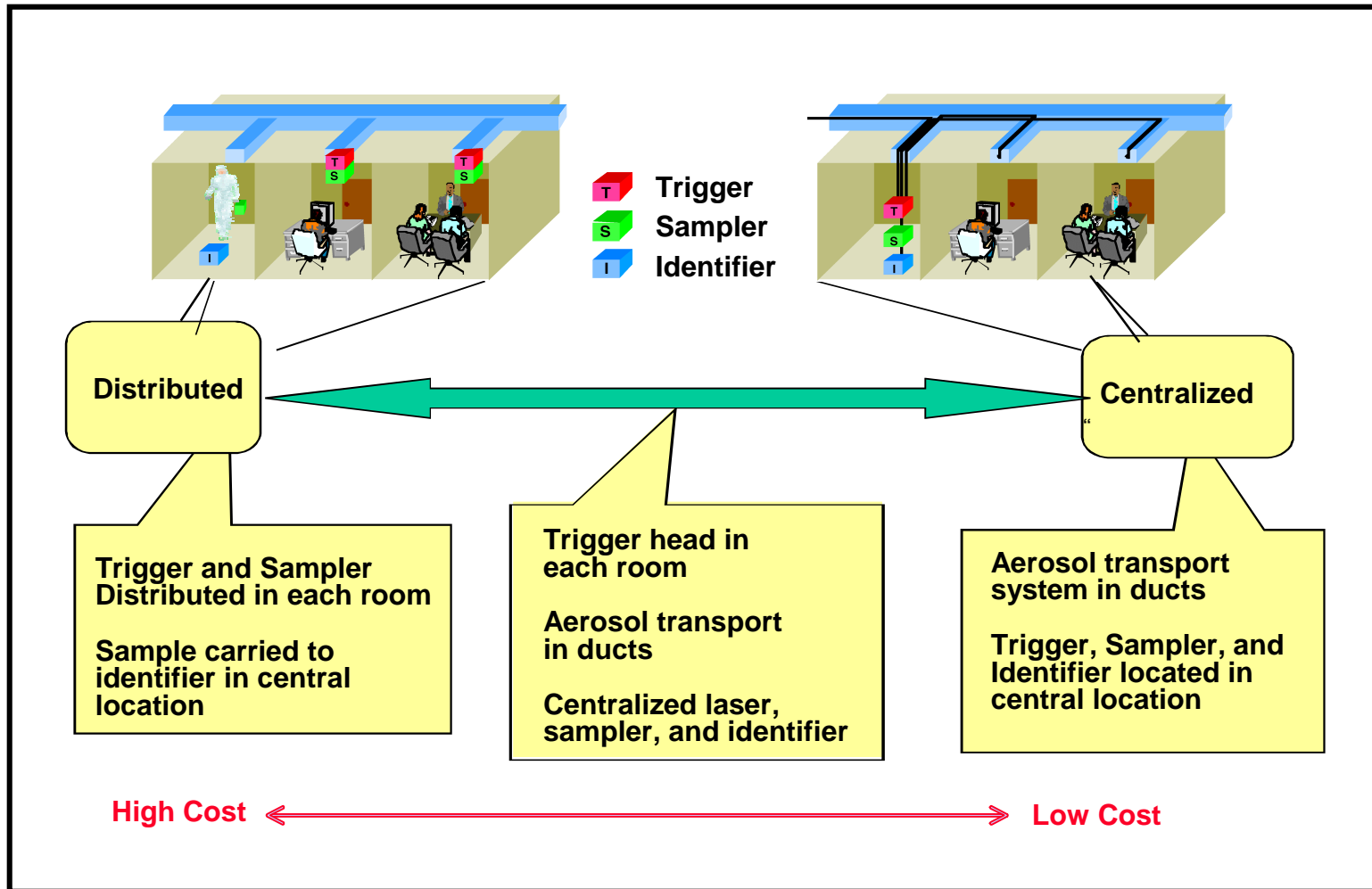


State-of-the-Art Bio / Chem Sensors



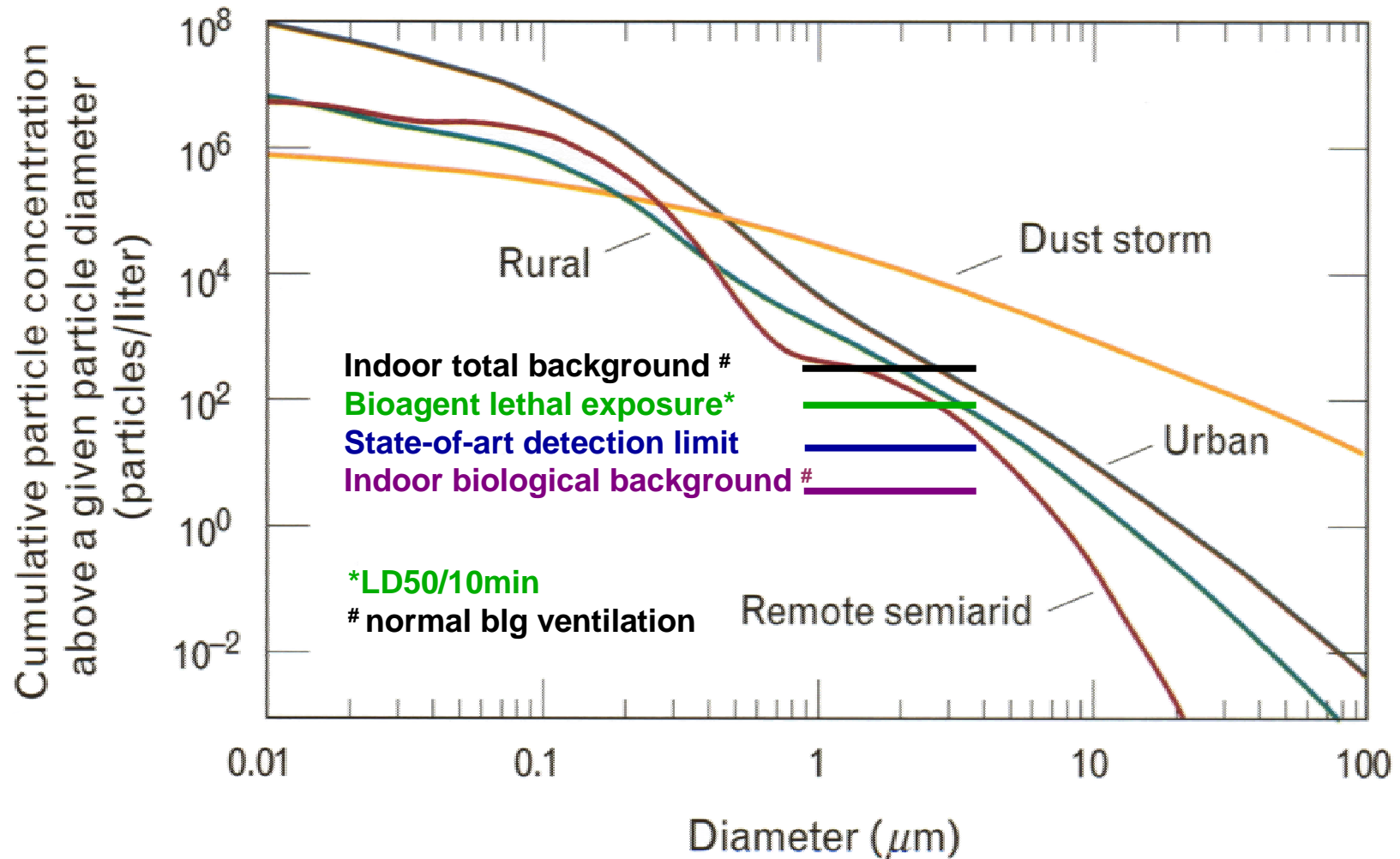


Sensor Architectures for Building Defense





Atmospheric Aerosol Content

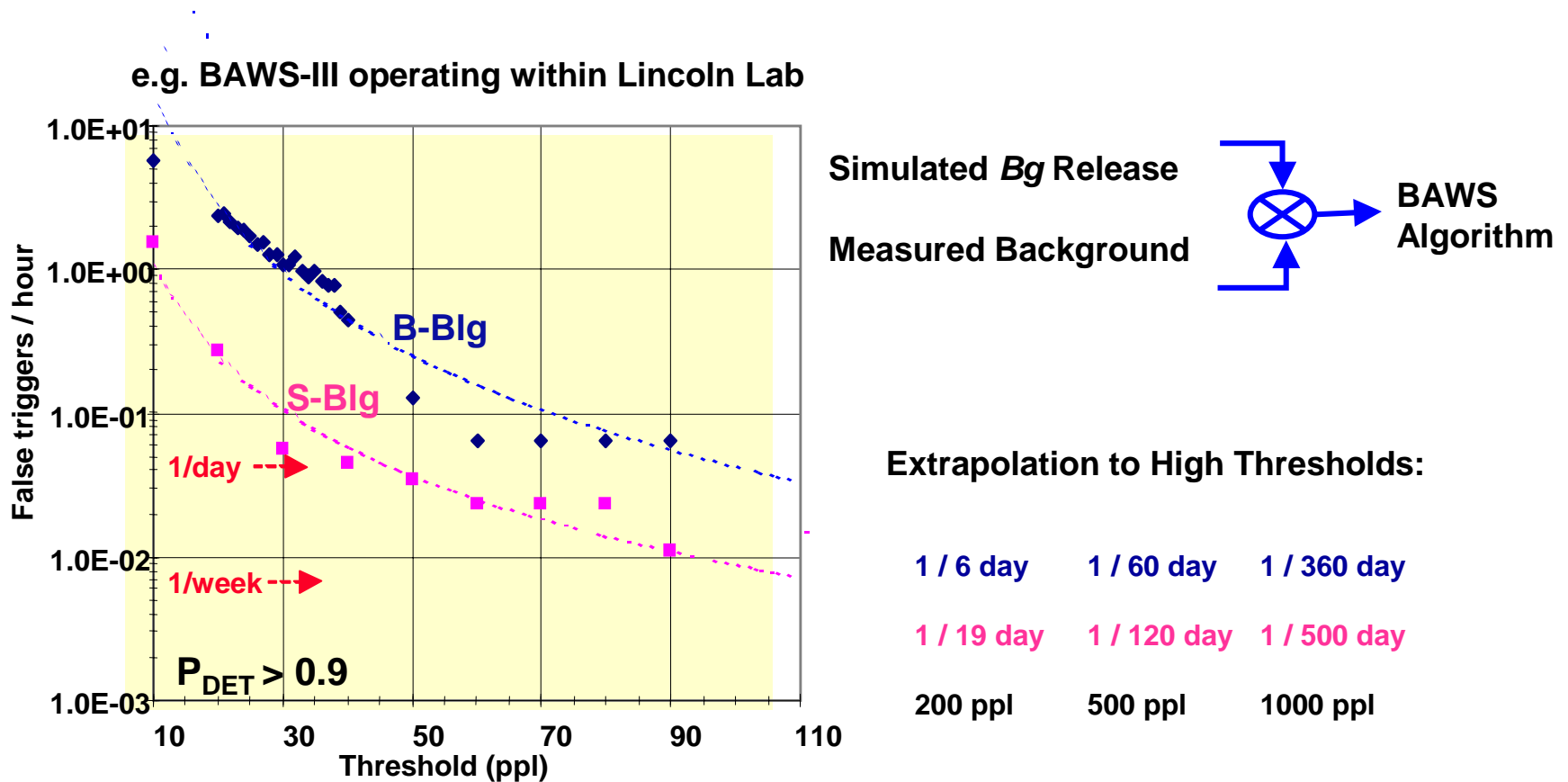


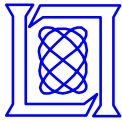
After R. Jaenicke in Aerosol-Cloud-Climate Interactions, P. Hobbs editor (1993).



False Trigger Rate

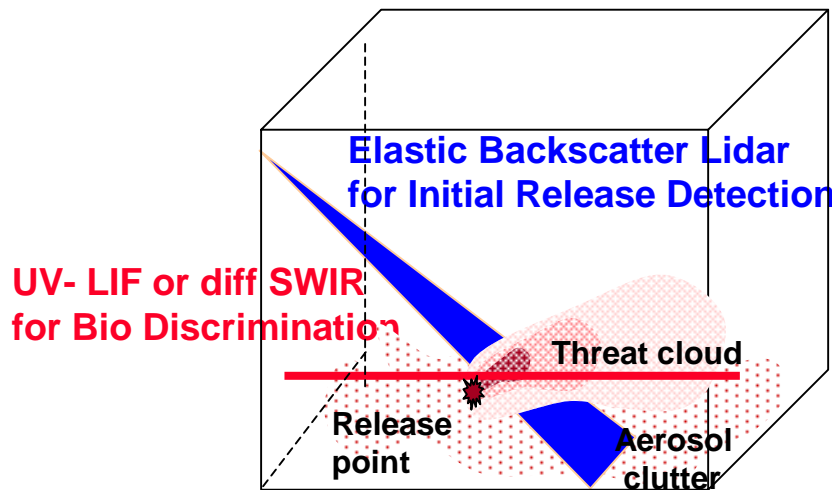
- Sensor will trigger less frequently when operated at higher threshold.





Indoor Standoff Aerosol Detection

- Any point sensor is limited by aerosol transport in large open space.
- Need to detect the release promptly at a specific point
- Bio sensor concept:



Minimum for detecting 1000ppl threat

	Dwell time	Range cell
Elastic	0.1 sec	1 m
UV LIF	10 sec	3 m
Diff SWIR	10 sec	2 m

50m range, eyesafe laser; 100 lux lighting



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Facility Protection Measures

- **Physical security**
 - **Protect fresh air intakes (location, access, surveillance)**
 - **Personal screening (may be difficult in civil defense)**
- **Ventilation system protection**
 - **Passive air filtration**
 - › **Upgrade filters (best ASHRAE filters > 95%)**
 - › **Overhauling the system (HEPA / carbon)**
 - **Positive pressure to overcome infiltration**
 - **Sensor triggered airflow control**



Passive Air Filtration

- **In-line passive filtration is well established**
 - HEPA filters remove >99.97% suspended particles > 0.3 μm .
 - Activated carbon filters adsorb most chemical vapors
- **Substantial cost to overhaul existing ventilation system**
 - Purchase and replacement of filters
 - Increased blower motors for higher pressure drop
 - Reinforced ductwork
 - Very little infiltration is allowable (gasket seals, overpressure)
 - Increased energy costs
- **Research topics**
 - Low pressure drop filter structures
 - In-line sterilization (UV, radiation, thermal,...)



Facility Defense Effectiveness

Estimated exposure reduction
to external bio attack

- | | |
|---|------------------|
| • “Unprotected” building | 1 |
| • Upgraded standard filters
(or in-room HEPA) | 10-100 |
| • In-line HEPA filters | 100-1000 |
| • In-line HEPA filters
with overpressure
and triggered airflow control | > 1000 |



Summary

- **Most buildings with ventilation systems are vulnerable to aerosol attack via a number of scenarios.**
- **Without deployed sensors, an attack may go undetected resulting in higher exposure and lack of treatment to exposed occupants.**
- **There are some simple measures that can be used to increase situational awareness and provide limited protection.**
- **A substantial degree of protection can be achieved at substantial cost with sensor triggered airflow control and HEPA/carbon filters. In this case, sensors may be operated at higher thresholds.**