Facility Defense Against Aerosol Attack

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50 years

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Abstract

Subject Terms

Report Classification unclassified	**Classification of this page** unclassified
Classification of Abstract unclassified	**Limitation of Abstract** SAR

Number of Pages
19

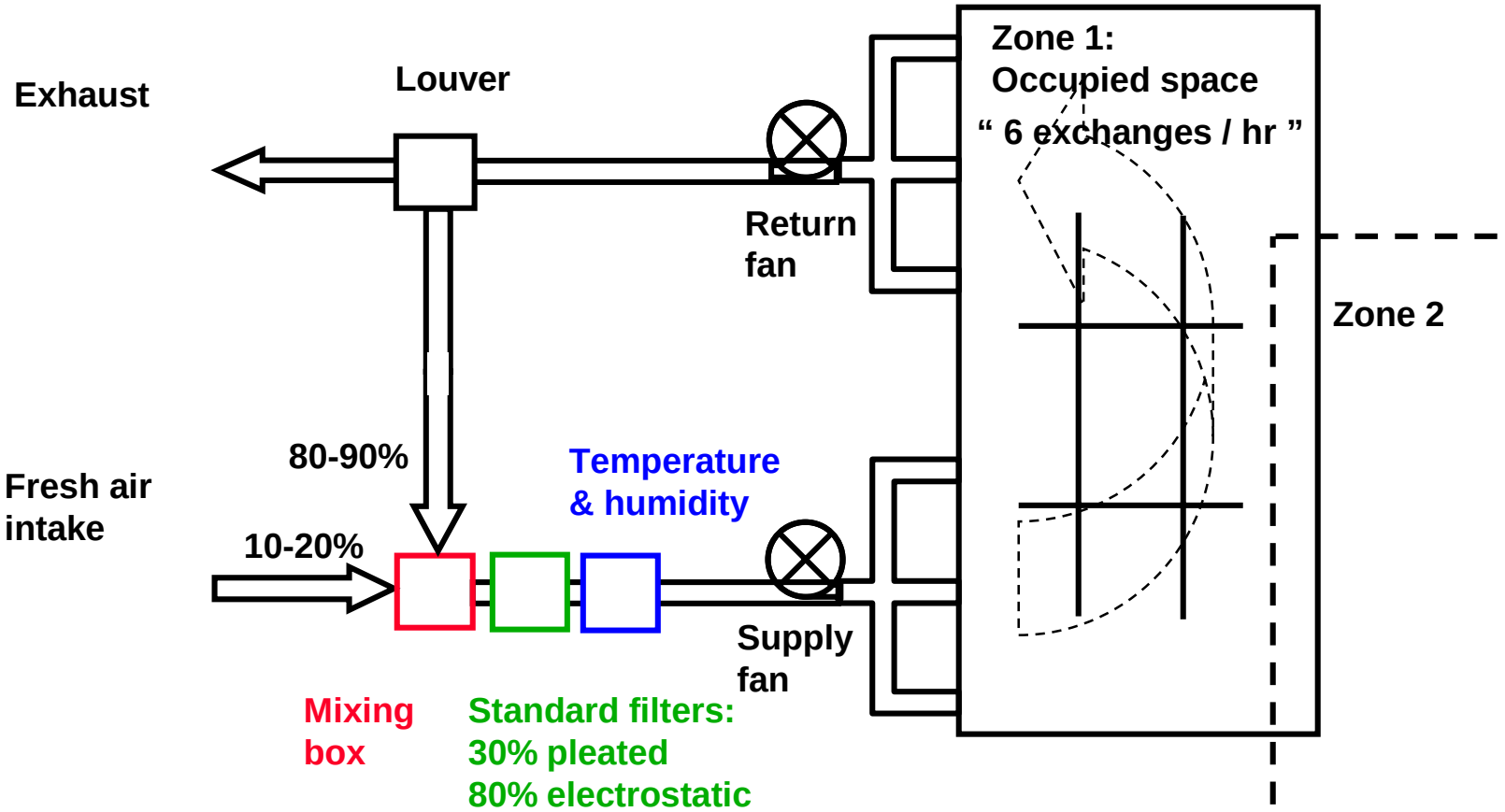
Outline

- **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**

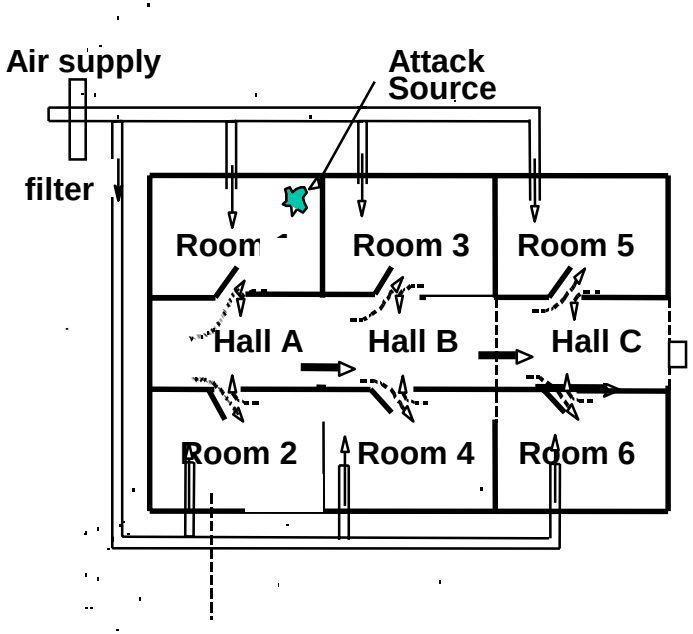
1 gram bioagent uniformly dispersed into 10^8 liter building (100m x 100m x 10m);

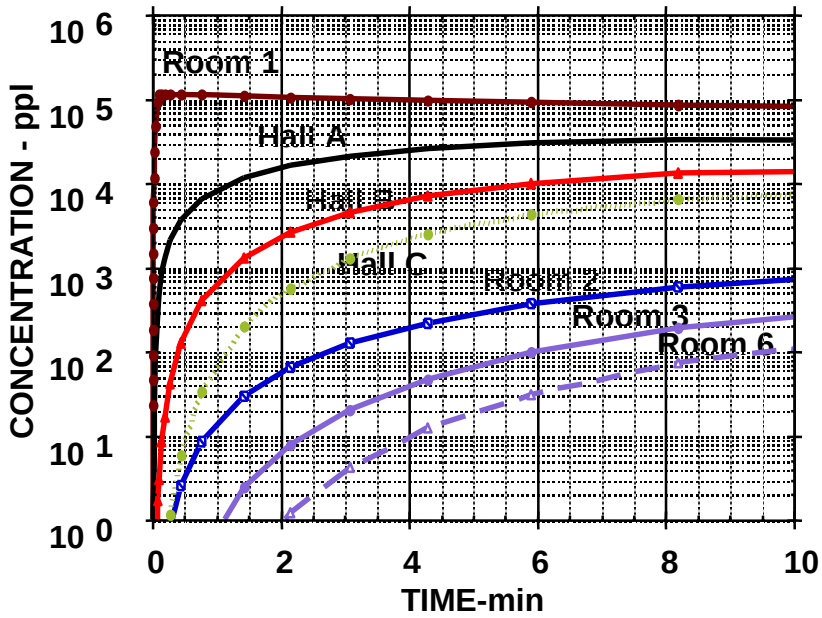
Corresponds to lethal exposure (100 ppl x 10 liter/min x 10 min; 10^{10} particles /gram)

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

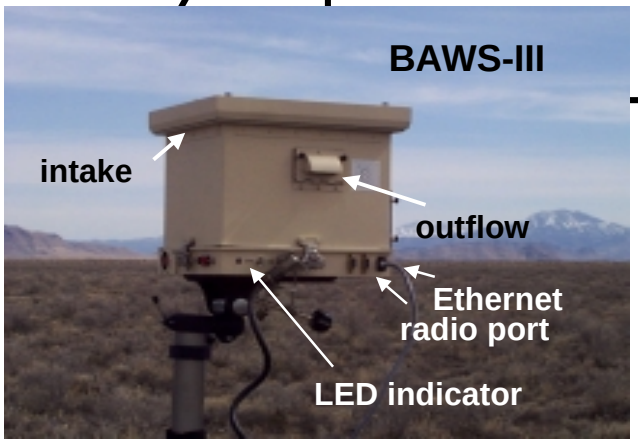
- **Issue alarm**
  - **initiate facility response**
  - **high $Prob_{detection}$; low $Prob_{false\ alarm}$; wide range of agents**
- **Identification of agent**
  - **initiate medical treatment**
- **Mapping of contamination zone**
- **Assessing decontamination (“all-clear”)**

State-of-the-Art Bio / Chem Sensors

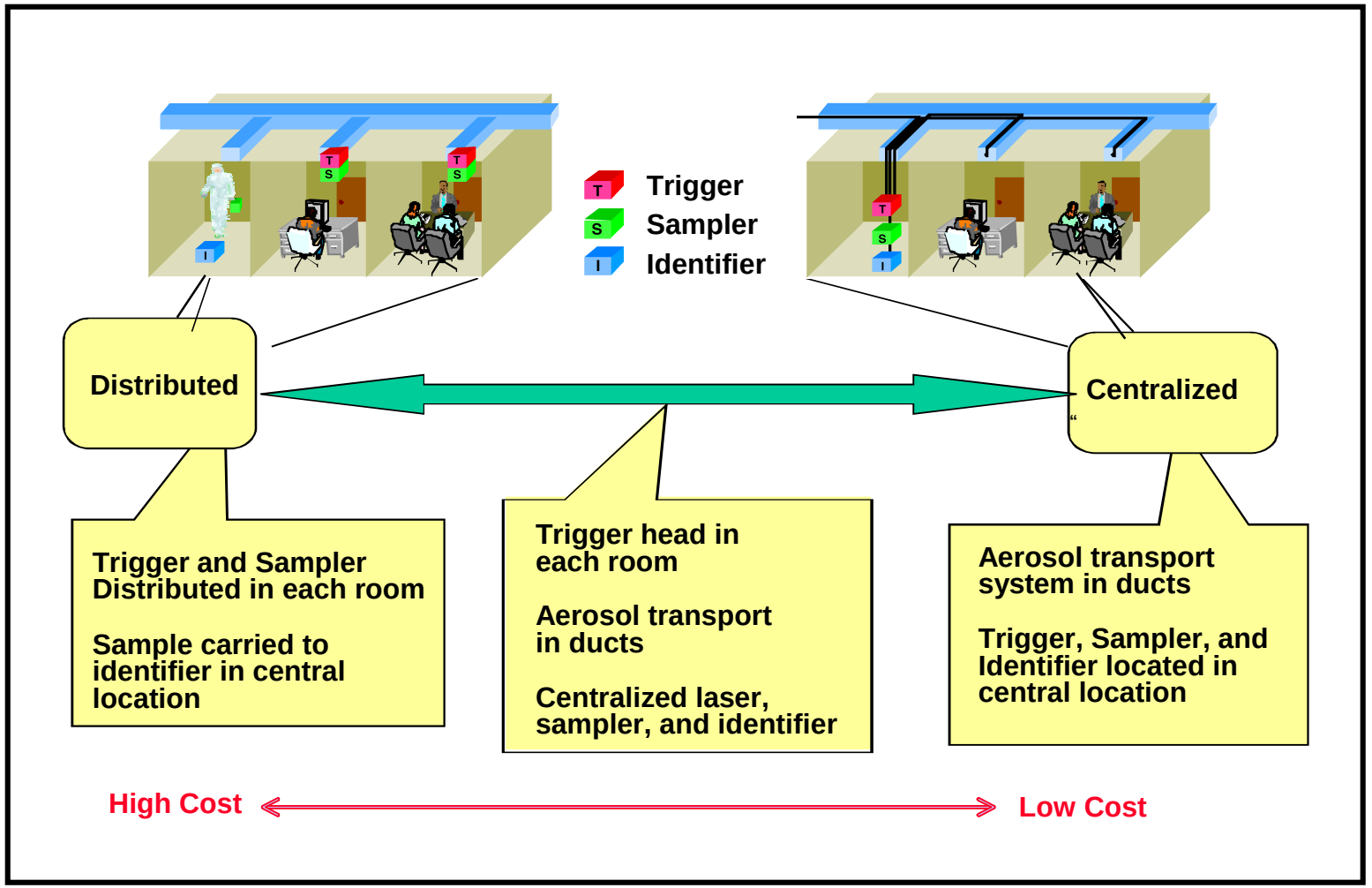
	Biological	Chemical
Sample based	Culturing Immunoassay strips PCR / DNA analysis	Detection tickets Gas chromatography / mass spec
Continuous monitoring	Particle number, size UV laser fluorescence	Ion mobility spec Surface acoustic wave

REC BioHAZ

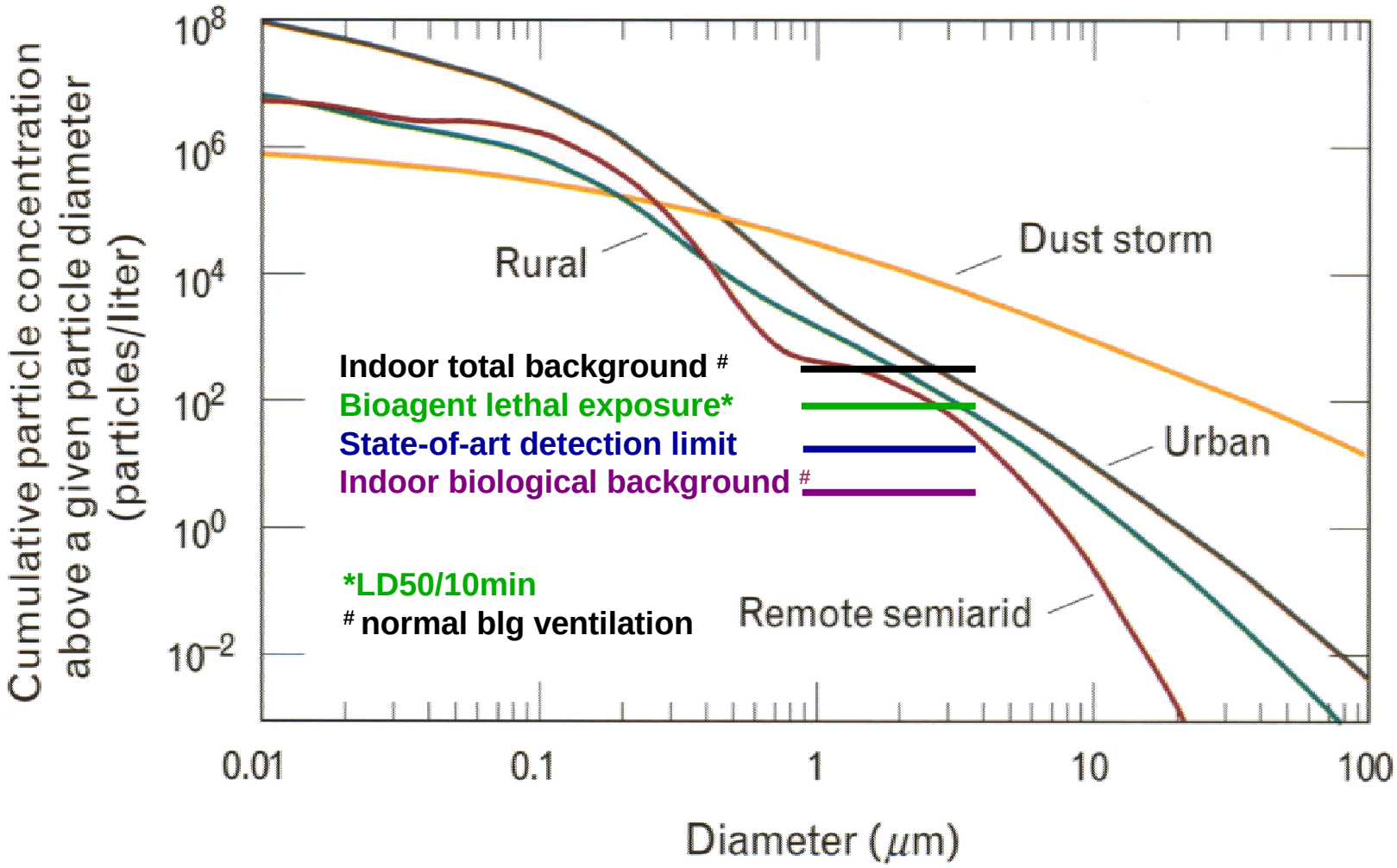
Graseby GID-2A



Sensor Architectures for Building Defense



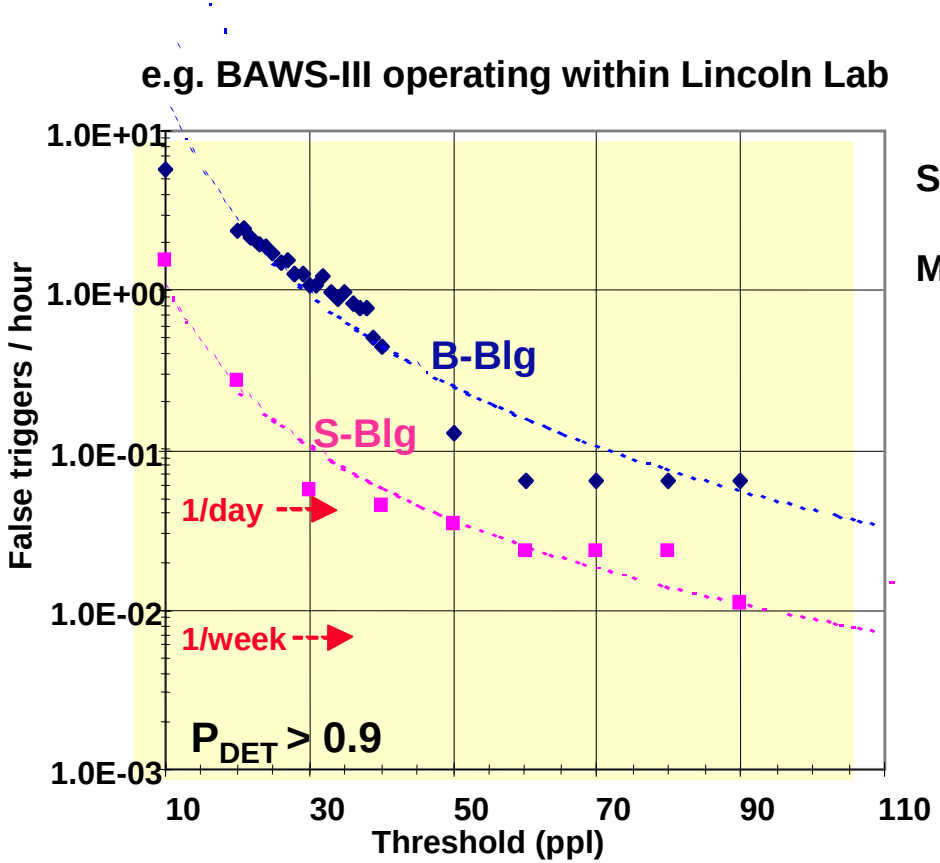
Atmospheric Aerosol Content



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

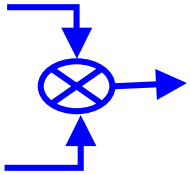
False Trigger Rate

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



Simulated *Bg* Release

Measured Background



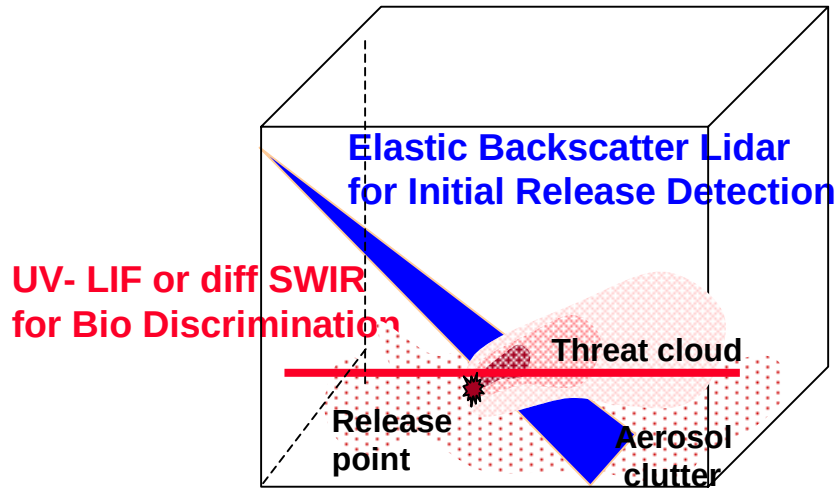
BAWS Algorithm

Extrapolation to High Thresholds:

1 / 6 day	1 / 60 day	1 / 360 day
1 / 19 day	1 / 120 day	1 / 500 day
200 ppl	500 ppl	1000 ppl

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 um.**
  - **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.