Immune Building Program

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National Defense Industrial Association

Joint Program Management Office for Collective Protection

Collective Protection Conference

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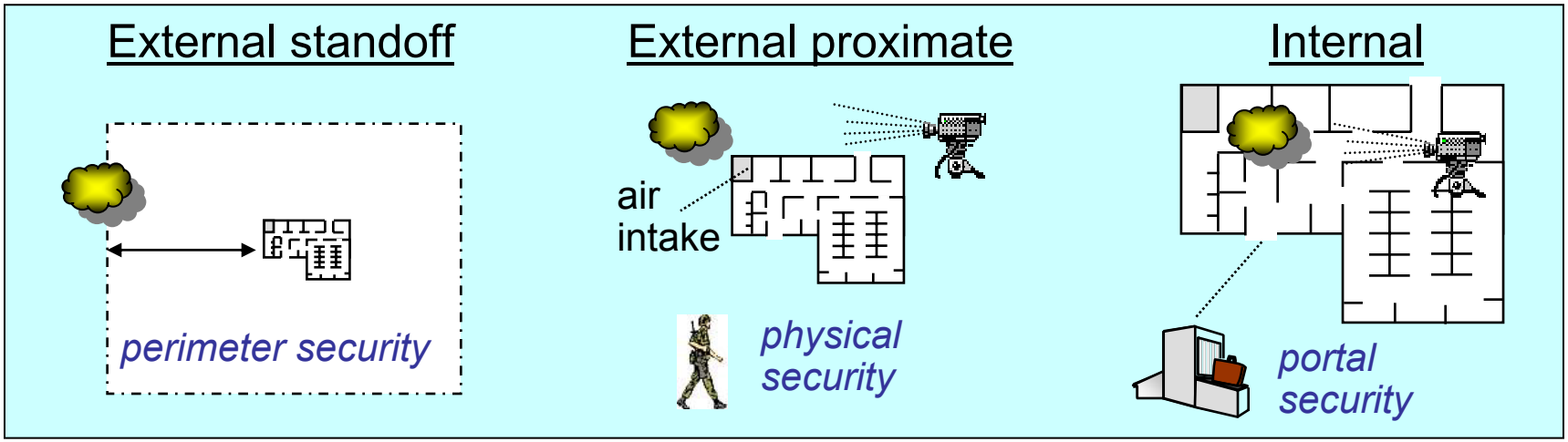
Overview

Threat: aerosolized chemical or biological agents; toxic industrial chemicals (TICs)



Goal: Make buildings less attractive targets

Objectives:

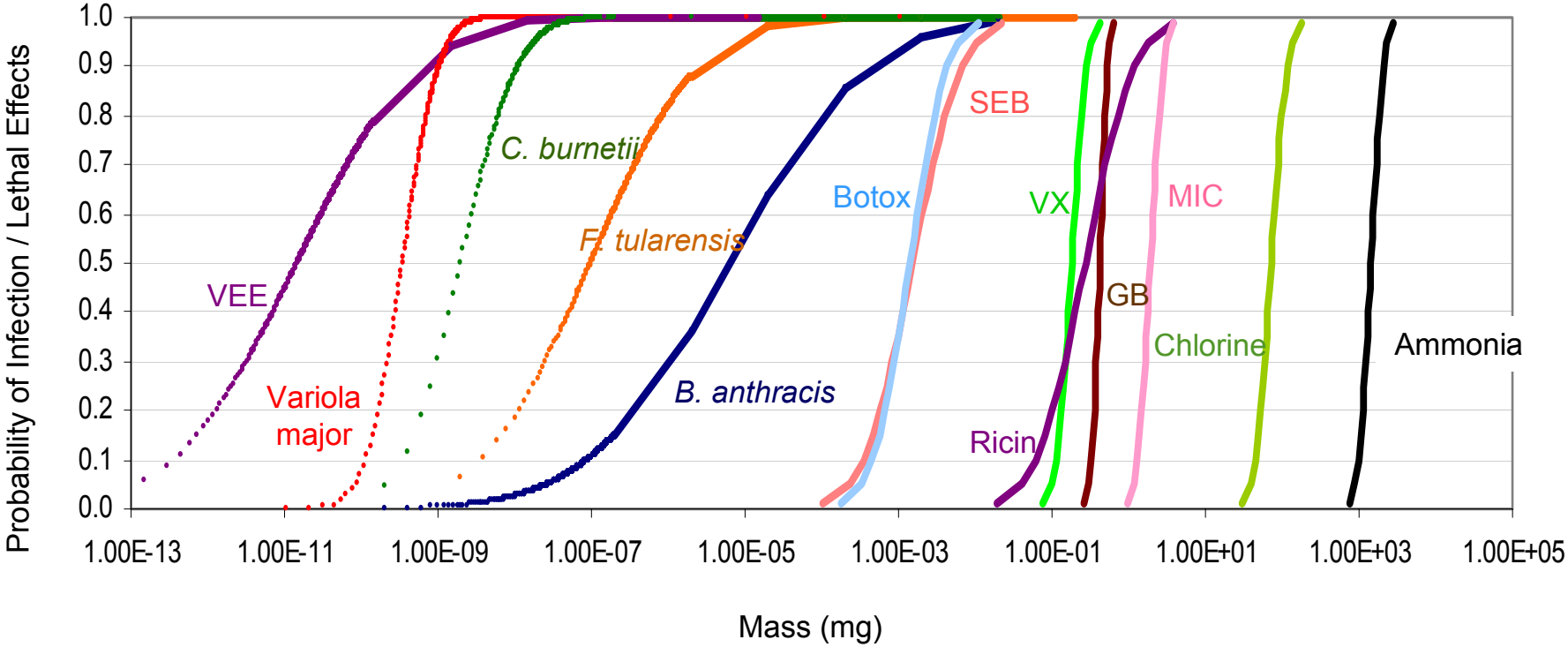
- Protect building occupants (keep aerosolized agent from harming humans)
- Restore building to function quickly
- Preserve forensic evidence

Payoffs:

- Save lives
- Restore OPTEMPO
- Determine appropriate treatment
- Attribute source of attack

Threat Spectrum

Viruses	Bacteria	Toxins and bioregulators	Chemical agents	TICs
• DNA viruses • RNA viruses	• Vegetative cells • Spores	• Neurotoxins • Cytotoxins • Enterotoxins • Mycotoxins • Neuropeptides	• Nerve agents • Blister agents • Blood agents • Choking agents	• Thousands of substances with characteristics

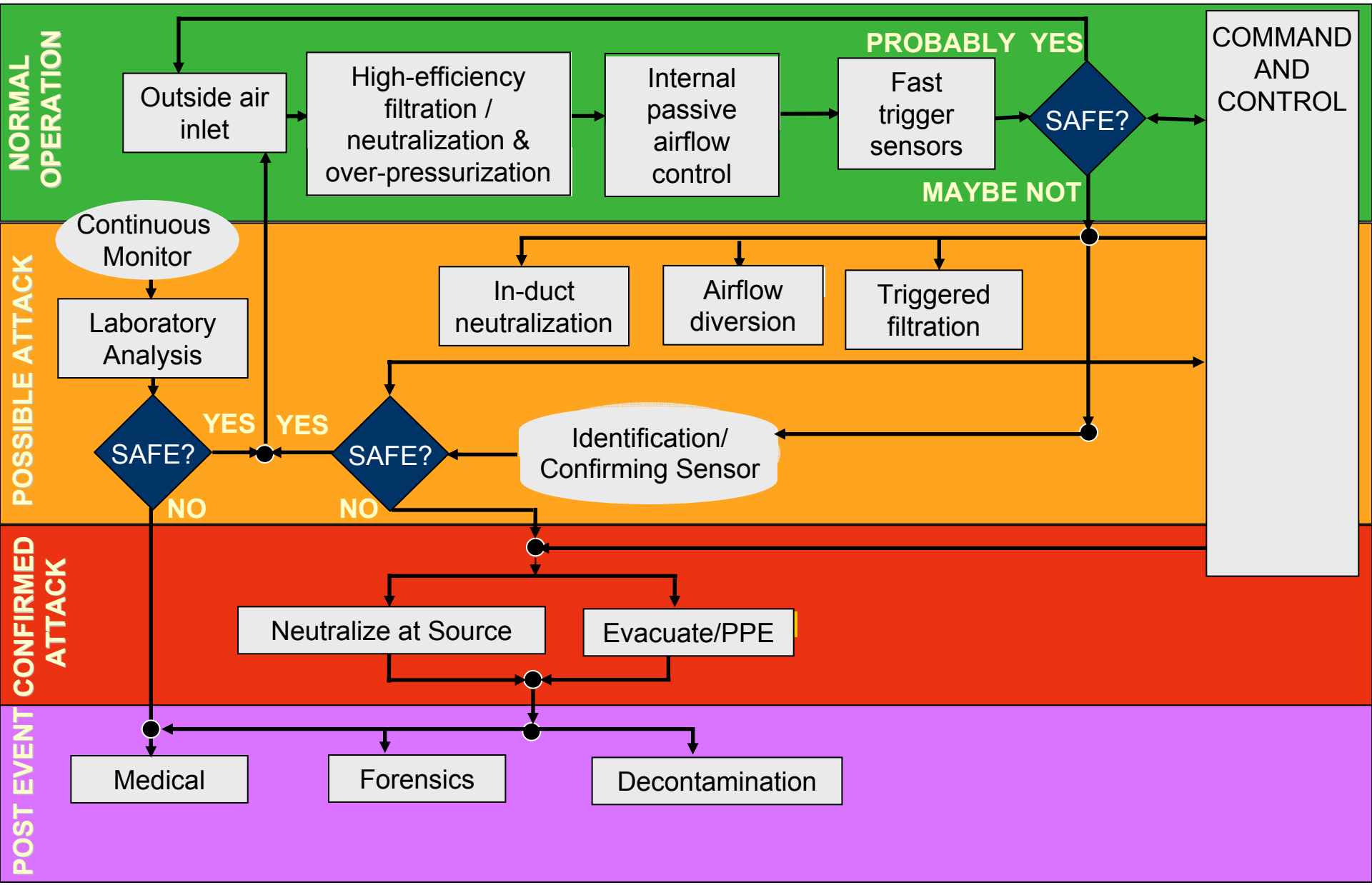


Based on Unclassified Sources

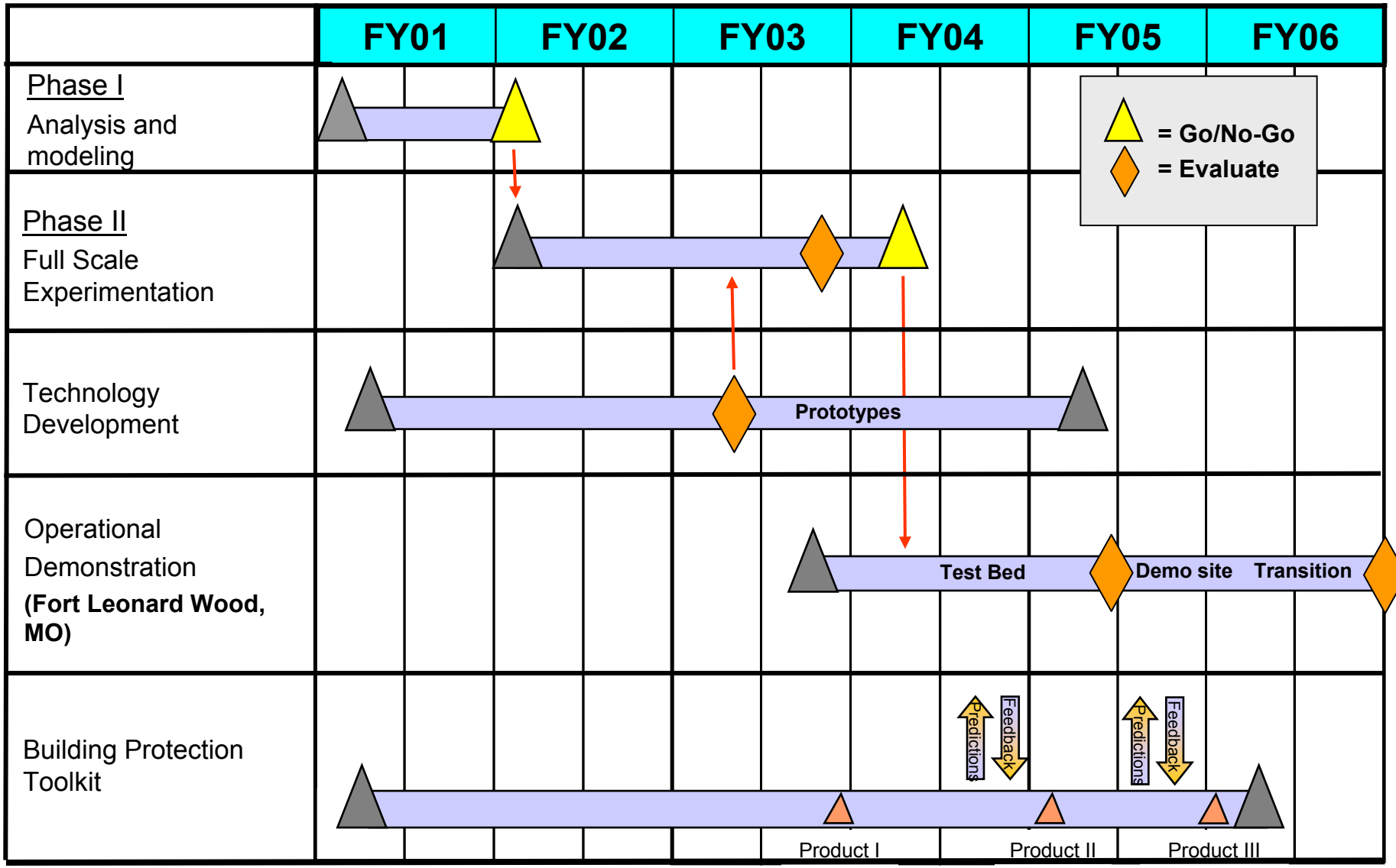
Challenges

Technical challenge	Program component
Many enabling components and technologies do not exist today	**Technology development** Develop required components and technologies necessary for system implementation
• Active-response building protection has never been demonstrated • Data and models to fully and confidently perform systems trades and systems evaluations do not exist	**Integrated system experimentation** – Conduct systems analysis and full-scale experimentation for candidate architectures – Design, implement, and evaluate optimized systems
Active chemical/biological building protection has never been used in an operational military building	**Full-scale demonstration** Install and demonstrate protection system at an operational military site
No validated capability exists to design and optimize building protection systems	**Toolkit** Develop and validate a software-based planning tool to assess building vulnerability and compare the cost and effectiveness of protection options

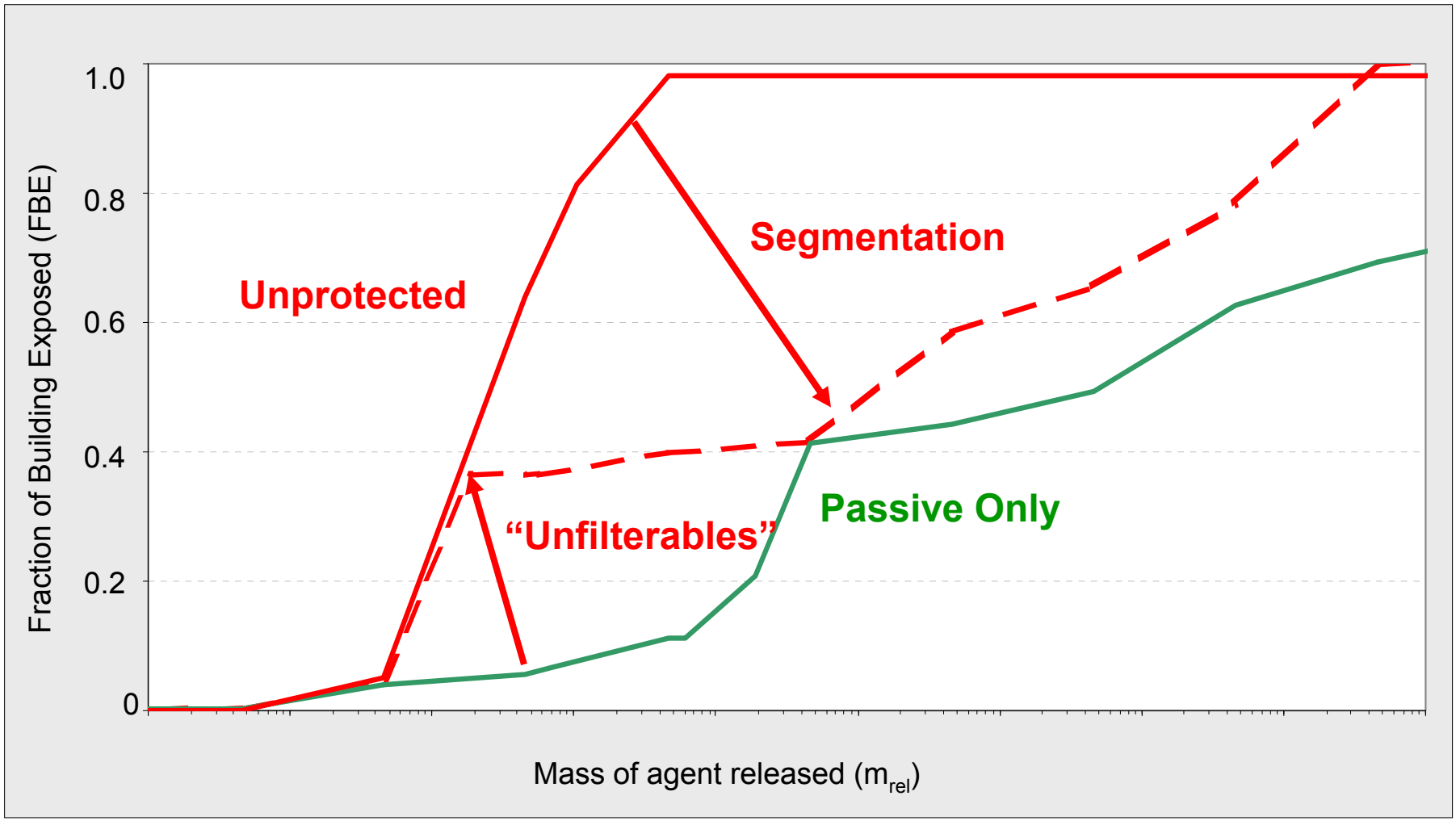
Building Protection Concept



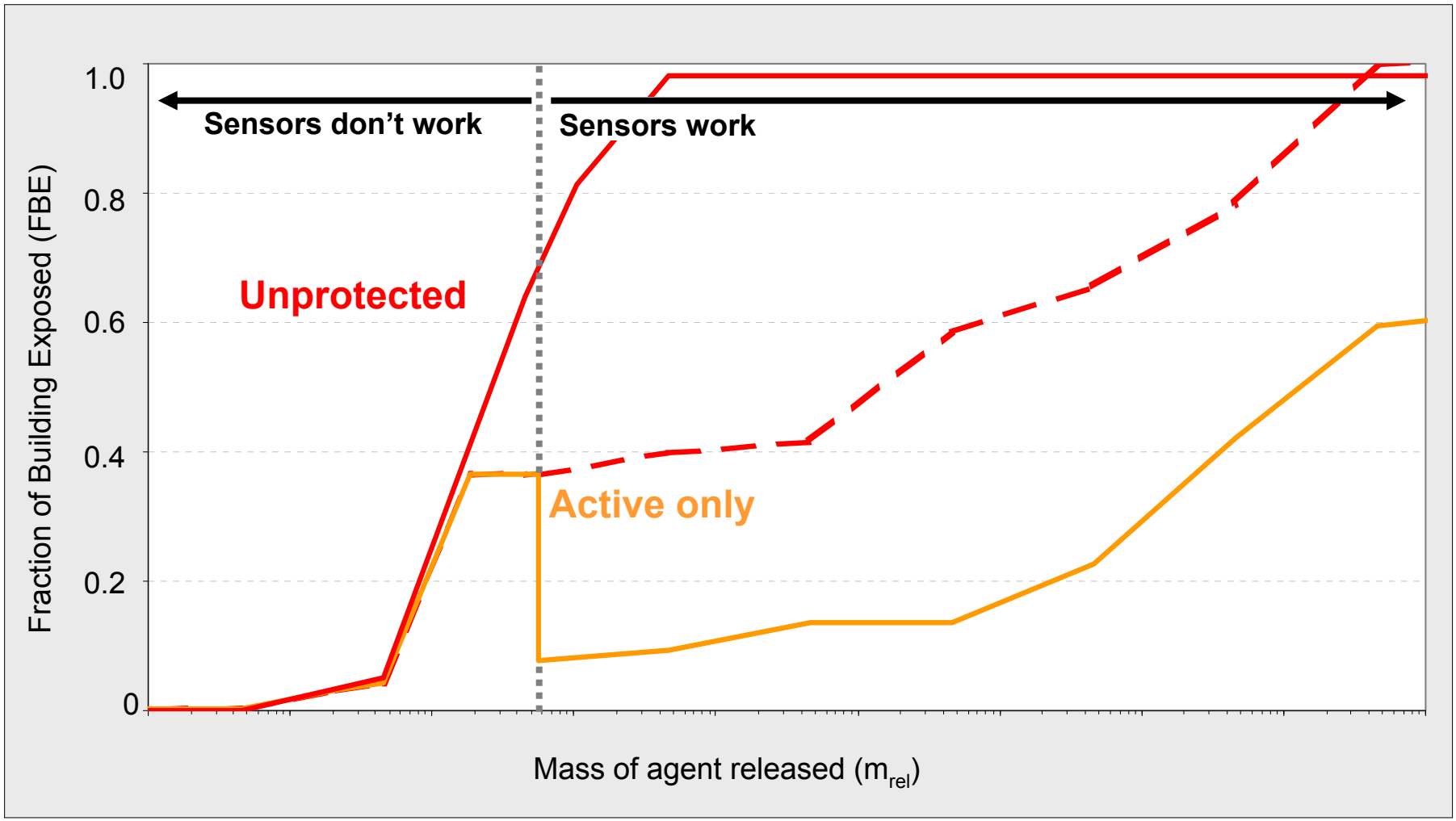
Components


FY01
FY02
FY03
FY04
FY05
FY06
Phase I
Analysis and modeling
Phase II
Full Scale Experimentation
Technology Development
Operational Demonstration
(Fort Leonard Wood, MO)
Building Protection Toolkit
= Go/No-Go
= Evaluate
Prototypes
Test Bed
Demo site
Transition
Predictions
Feedback
Predictions
Feedback
Product I
Product II
Product III

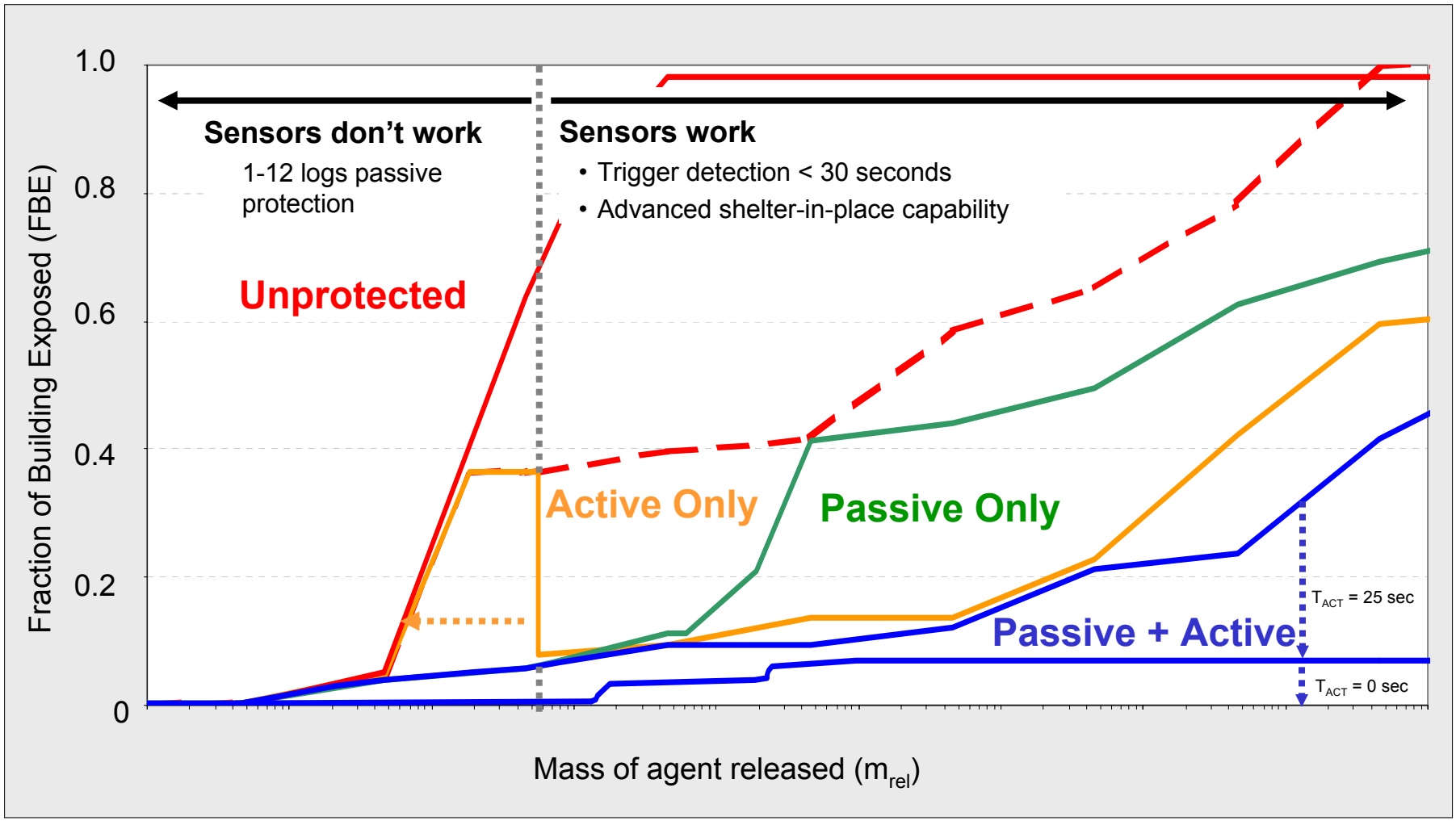
Modeling


1.0
0.8
0.6
0.4
0.2
0
Fraction of Building Exposed (FBE)
Unprotected
Segmentation
Passive Only
"Unfilterables"
Mass of agent released (m_{rel})

Modeling

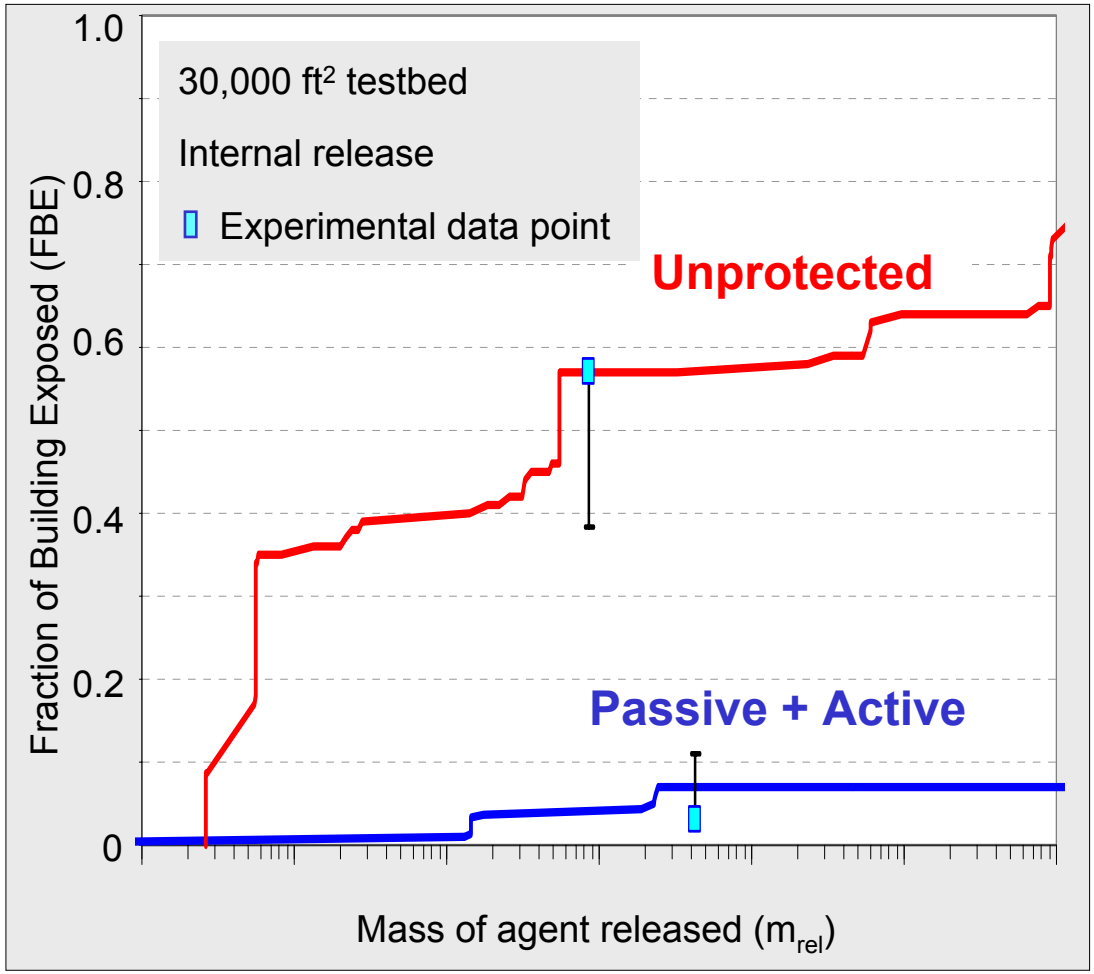

1.0
0.8
0.6
0.4
0.2
0
Fraction of Building Exposed (FBE)
Sensors don't work
Sensors work
Unprotected
Active only
Mass of agent released (m_{rel})

Modeling


1.0
0.8
0.6
0.4
0.2
0
Fraction of Building Exposed (FBE)
Sensors don't work
1-12 logs passive protection
Sensors work
• Trigger detection < 30 seconds
• Advanced shelter-in-place capability
Unprotected
Active Only
Passive Only
Passive + Active
T_{ACT} = 25 sec
T_{ACT} = 0 sec
Mass of agent released (m_{rel})

Testing

- Active strategies are critical
  - Experiments show sensors effectively initiate active protection
- Optimal architectures include both passive and active components
- Immune Building systems can be applied to diverse building types
  - Specifics will differ from building to building: characterize beforehand (to design an appropriate system) and afterwards (to maintain performance)
  - Coordinate design with HVAC, fire suppression, blast protection, etc. to avoid conflicts (e.g., structural, airflow)



Demonstration

Challenge the IB system in an *occupied* building under real-world *operating* conditions:

- IB System sensors, neutralization, filtration, and active controls will be fully propagated in building
- Releases in arbitrary locations and will include internal and external releases for *BOTH* chemical and biological threats
- Challenge against simulants for spores, encapsulated agents, filter penetrants (SF_6), low vapor pressure agents, mid-vapor pressure agents, and dusty agents
- Subset of releases carried out as independently refereed validation tests

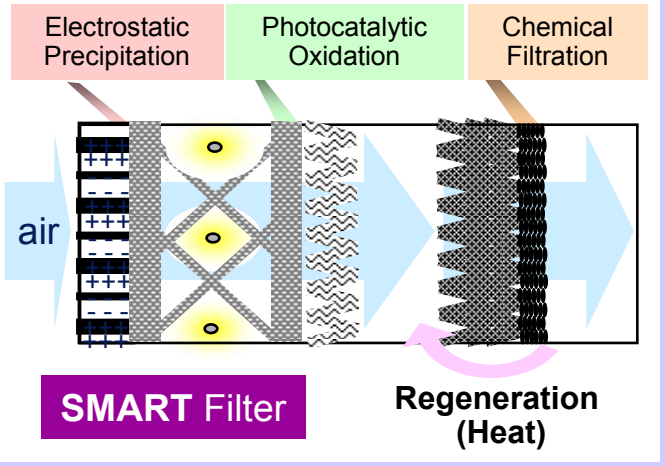
Nord Hall, Fort Leonard Wood, MO

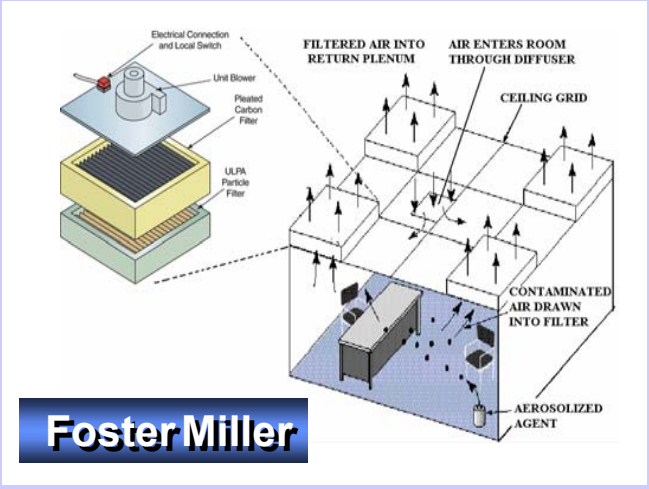
IB System Installation is complex and risky

- Modeling will reduce risk in the design phase
- Testbed will be utilized to optimize strategies, components, and CONOPS

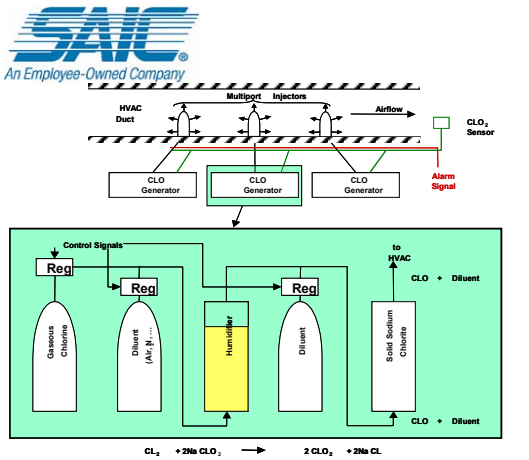
Technology Development

Advanced Filtration

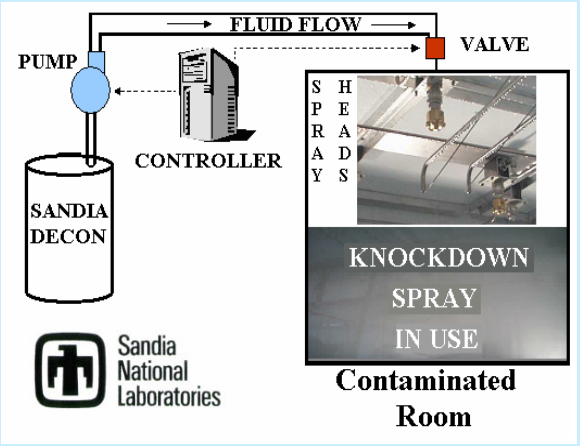


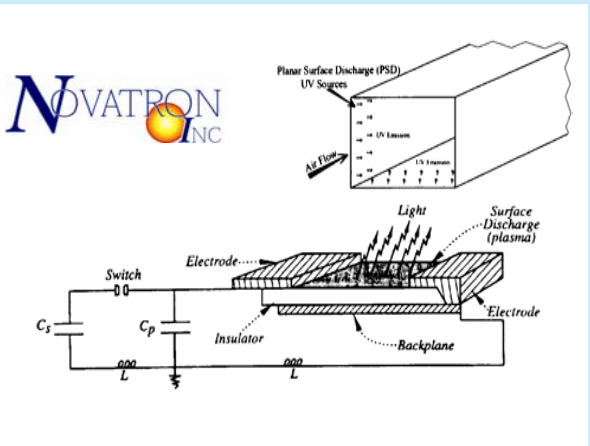


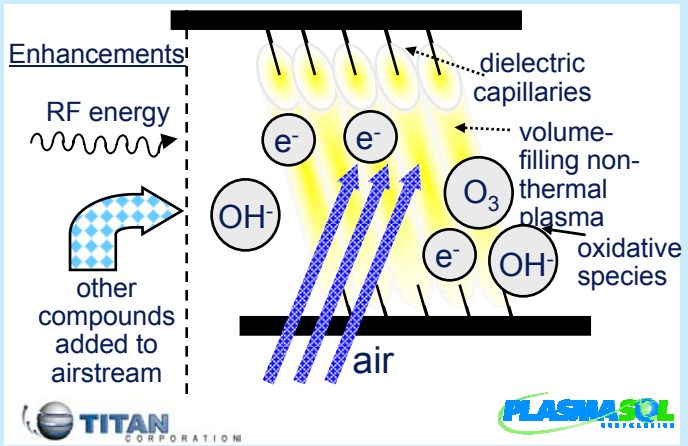
Decontamination



Real-Time Neutralization

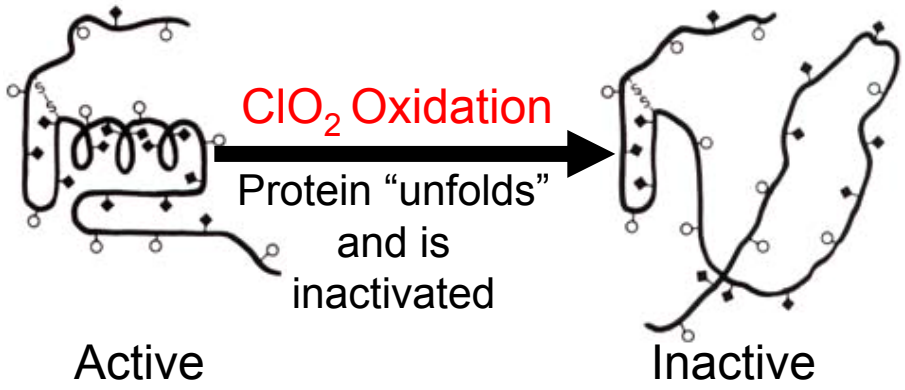




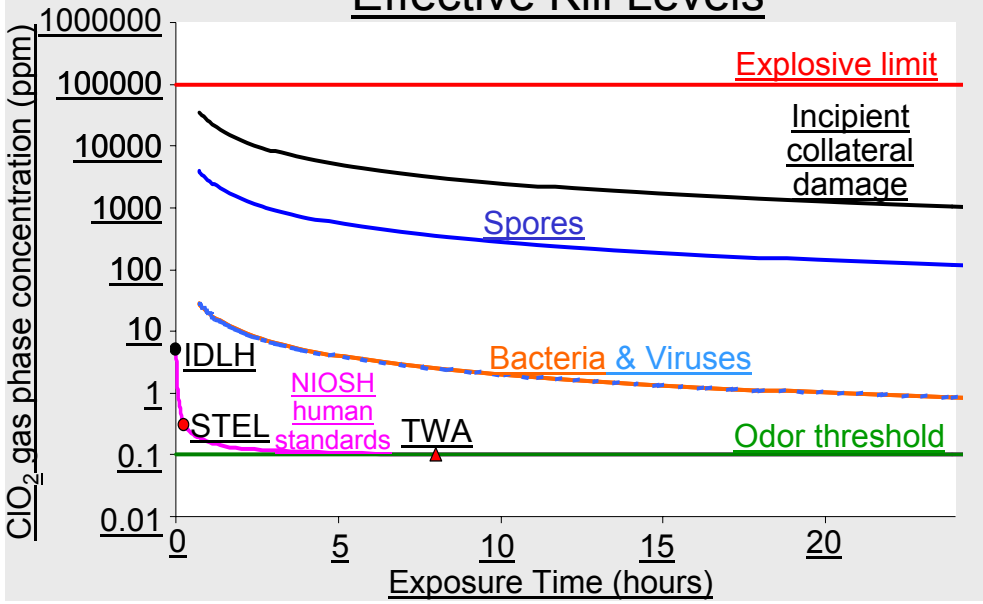


Chlorine Dioxide Effects

Mechanism of Inactivation



Effective Kill Levels



U.S. Government Joint Program

- Demonstrate and validate the effectiveness of ClO_2 decontamination technology in a building
- Develop and validate EPA approved decontamination protocols and techniques
- Transition capability to government and industry

Collateral Damage

20,000 ppm-hours ClO_2

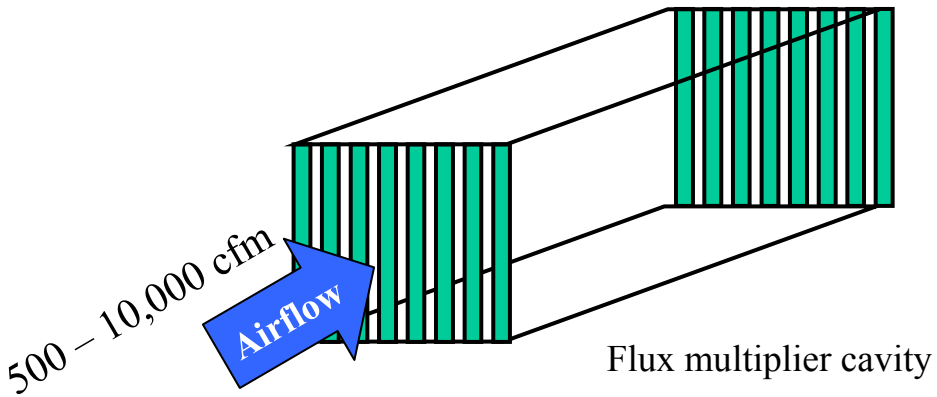
- Only polyurethane foam seriously damaged

200,000 ppm-hours ClO_2

- Copper and steel corroded
- Polycarbonate discolored

Technology Transition:
Novatron High-Intensity UV

Intense UV source



Flux multiplier cavity

Approach

Creation of intense UV and killing of microorganisms in HVAC

Technology

- Low power, continuous-wave UV DC lamps
- Uniform photon flux multiplication (increases UV flux by a factor of 50 or more)
- UV interaction with DNA to induce crosslinking
- Air sterilization – in less than 1 second – only a few feet needed for high kill levels even for high velocity airflow
- *B. subtilis* 4.5 to 6.2 log kill
- 0.3 I.W.G. pressure drop


BP246i BioProtector commercial prototype

Technology Transition:
Cold Plasma

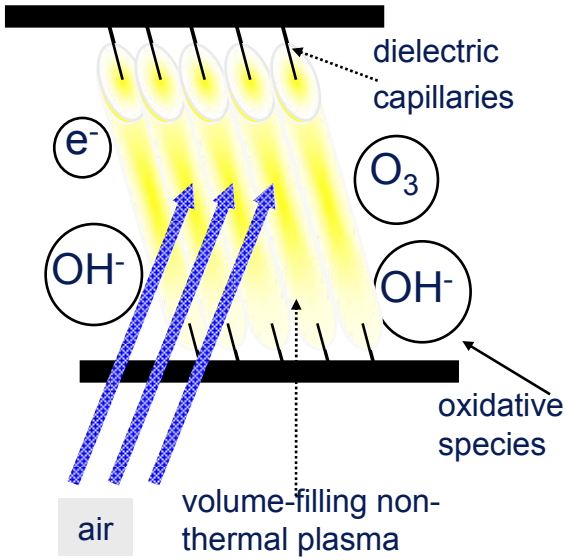
Cold Plasma Neutralization

- In-duct air neutralization
- Scalable – low power, “real-time kill” (single pass) [duct mounted]

PlasmaSol Technology

- Ambient air plasma generator
- Non-thermal electrical plasma
- Dielectric wall discharge suppresses the glow-to-arc mode transition
- Electrode configuration enables plasma to have 100% contact with species of gas treated
- High energy density (typically energy densities of barrier, corona discharge are 0.01 – 0.1 w/cm^3)
- Air / medical equipment sterilization

Agent	Log reduction
B. anthracis	> 3 (experimental constraint)
DFP (nerve)	> 1 (model agreement)

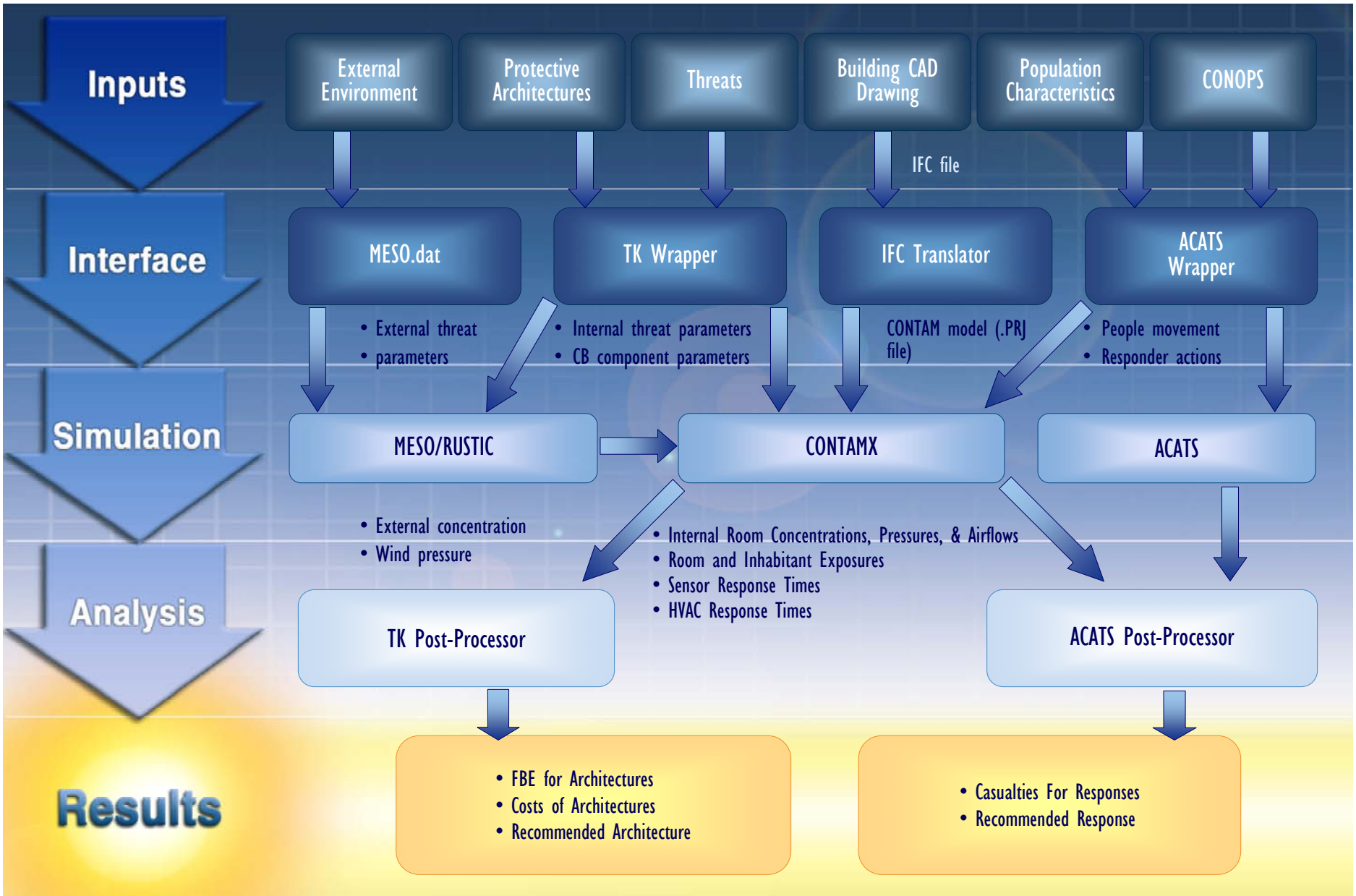


TITAN Technology

- Cold plasma induced hydroxyl radical generation (BIT)
- Activation of H_20_2 yielding exponential number of long-lived hydroxyl radicals
- Mesh “active layer”
- Scaleable system

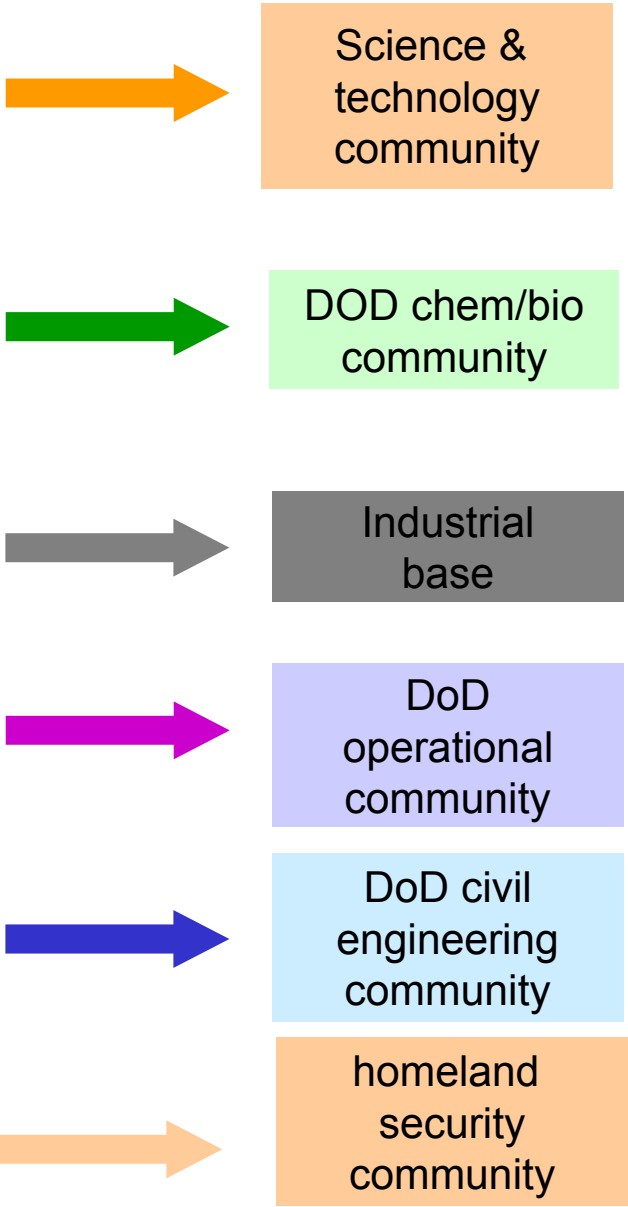
Agent	Log reduction
B. subtilis (spore)	> 6
CEES (mustard)	> 5
Diazinon (nerve)	> 5

BPTK Modeling and Simulation



Immune Building Transition

- Demonstration system provides test platform for future technology development.
  - Improved sensors
  - Improved neutralization technologies
- Fort Leonard Wood will continue to operate the demonstration system (MOA in place, DoD memorandum issued for support beyond DARPA's departure).
- Contractor involvement helps mature building protection technologies.
- IB is coordinating with the DoD R&D and user communities.
- Promulgate IB lessons learned to protective building design processes (Toolkit).
- Working with homeland security community on technology development and extension of concept to tall buildings



Additional Information

Publicly accessible sites with additional information about the DARPA Immune Building Program:

http://www.darpa.mil/spo/programs/ib.htm

https://dtsn.darpa.mil/ibdemo/default.asp