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The Role of Cooperative Threat Reduction in Chem/Bio Terrorism Defense and Synergies with R&D

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Global Chemical and Biological Security

Sandia National Laboratories

Albuquerque, NM USA

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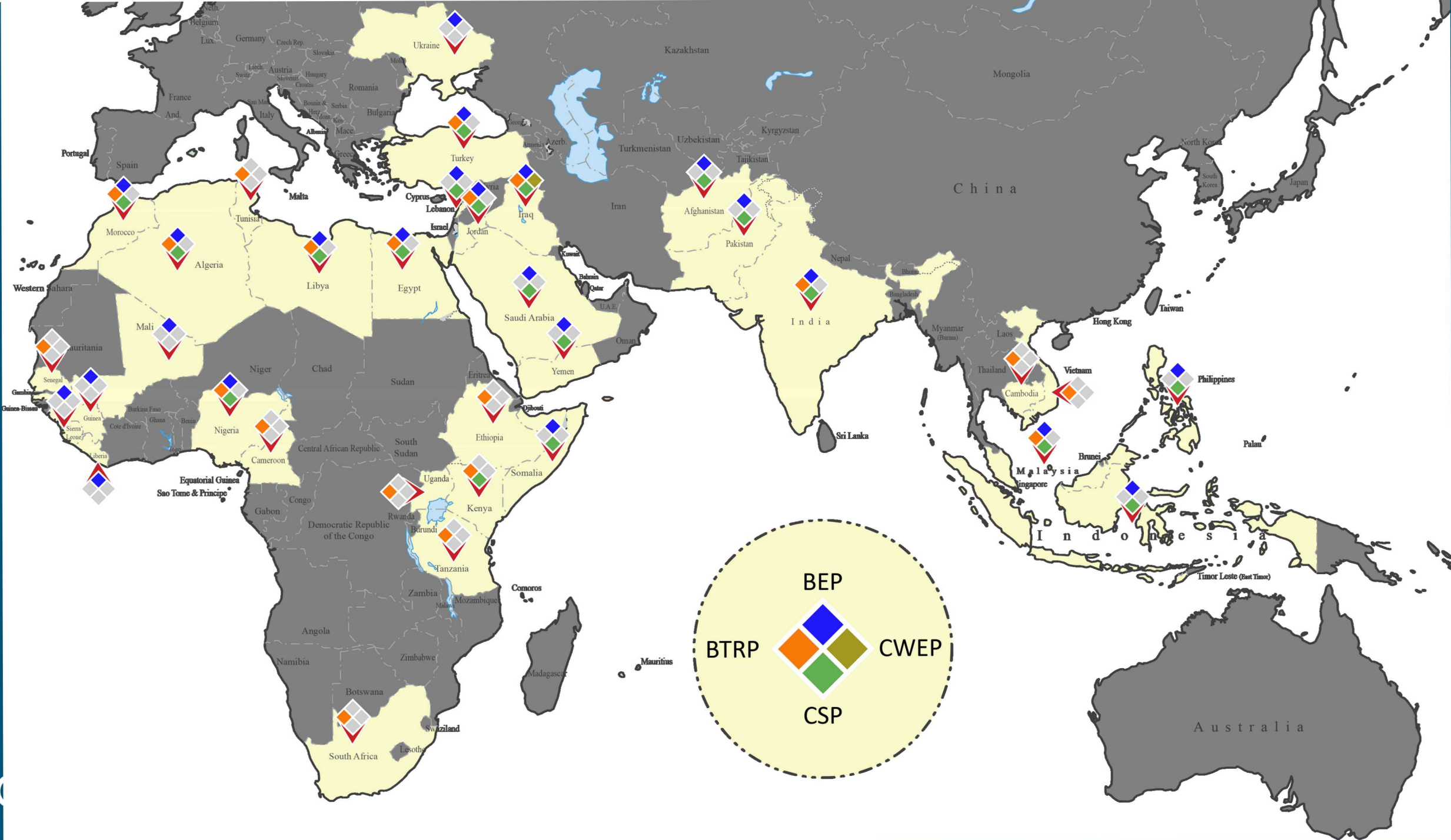
Who Are We?



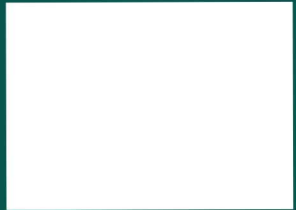
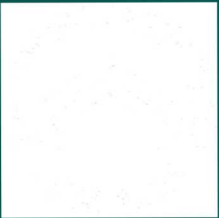
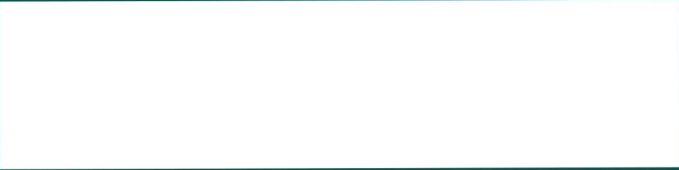
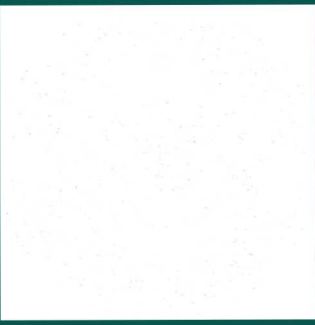
Innovative solutions for countering biological and chemical threats globally

- Strengthen capacities to safely, securely, and responsibly detect, handle, and control dangerous chemical and biological agents
- Promote the responsible use of chemical and biological agents, equipment, and expertise globally
- Improve understanding and management of the risks associated with accidental and deliberate misuse of chemical and biological agents
- Encourage global partnerships and adherence to international standards





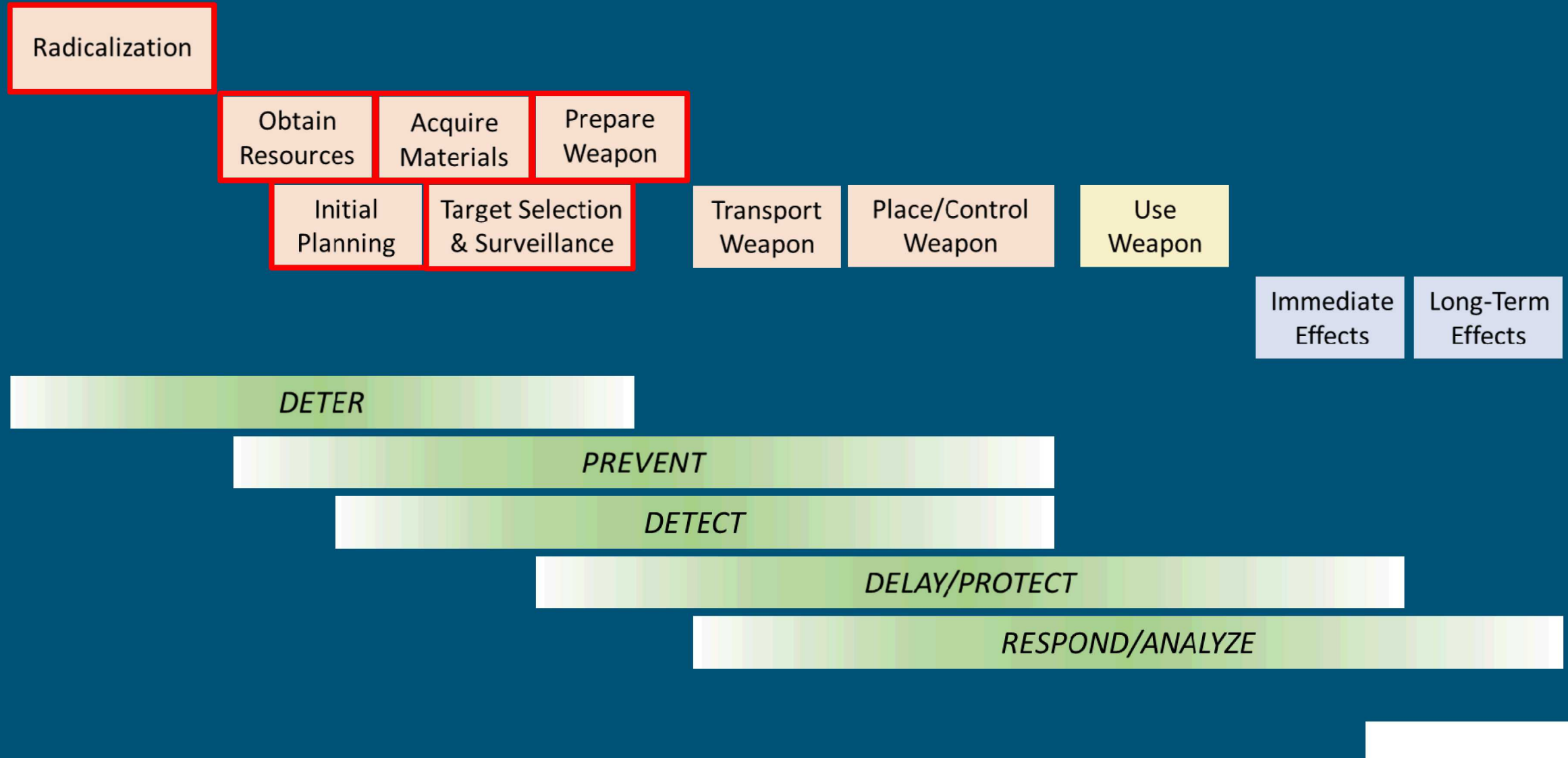
Our Sponsors and Partners



What

am I even doing here?

Terrorist Attack Sequence



Technology Solutions for Real Problems

We do research and development, but often with a specific set of drivers

- Final product affordability and sustainability
- Ease of use
- Ease of technology transfer / dissemination

So What have we done?



Challenge: *Bacillus Anthracis* in Low Resource Environments

- Diagnostic testing is critical to support public health and disease prevention
 - Prevents infected animals from entering the food supply and limits human exposure
 - Promotes proper carcass disposal so that the remains of infected animals are not left to contaminate the soil
- Gold standard is isolation/culture
 - Costly, dangerous, and potentially creates a repository of *Bacillus anthracis* that is stored at a given facility
 - Promotes dual-use skills and technology
 - PCR is not widely used because of limited access to reagents, cost, and lack of necessary skills

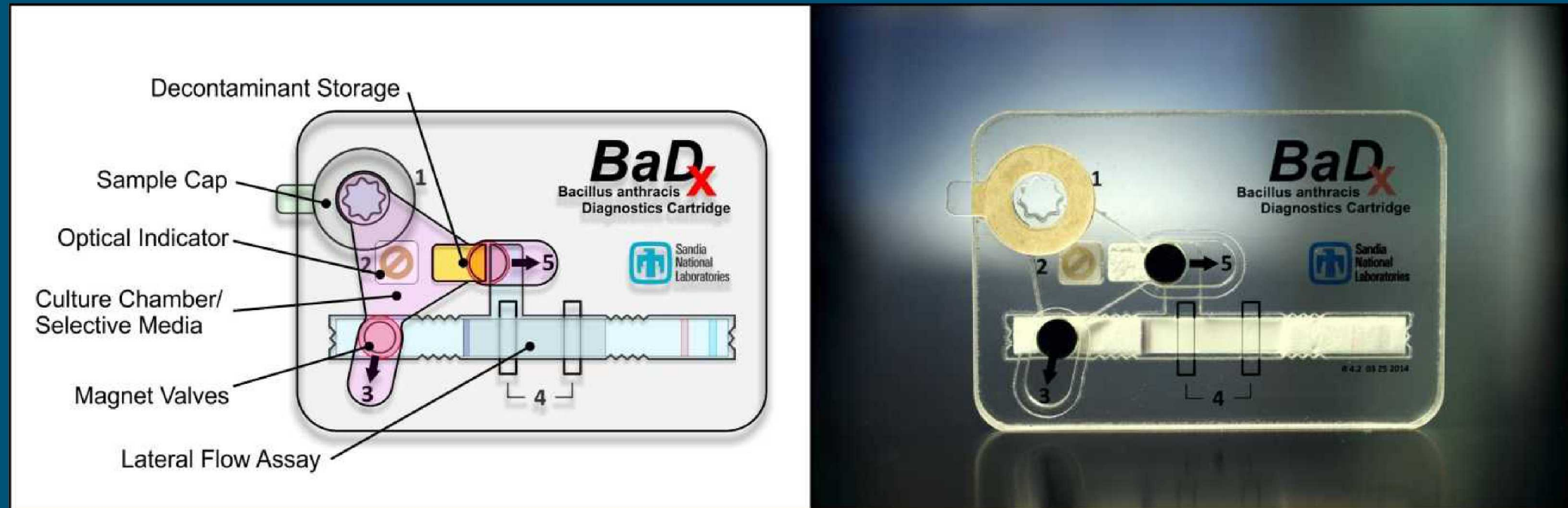


Solution Requirements

- Widely accepted by laboratory directors and staff
 - Leverage the gold standard of isolation and culture
- Promotes laboratory biorisk management
 - Reduces the proliferation potential
- Low cost
 - Resources are scarce in many countries where the risk is high
- Low detection limit (~100 spores)
- Easy to use
 - Laboratory staff have limited capabilities
 - Minimize dual-use skills
- Limited infrastructure requirements



B. anthracis Diagnostics (BaD_x) Cartridge



- Microfluidic platform for bacterial detection prepared from laser ablated plastic laminates
- Allows for rapid and inexpensive prototyping and design revisions†
- Self-contained, credit card-sized “Laboratory in a Pocket”

- One step lateral flow assay (LFA) for biodetection
- Selective bio amplification (micro-culture)
- On-device sterilization (chemical decon)
- External magnet actuated valves
- Materials cost: \$5-12 without cost of Tetracore LFA

† Edwards *et al. Biomicrofluidics* **2011**, 5, 044115; Harper *et al. Small* **2012**, 8, 2743.

Challenge: Chemical Inventories



- Tracking of and accounting for chemicals is an important safety and security best practice
 - Knowing the hazards in the lab is essential for safety
 - Accounting for chemicals of concern is needed for security
- Many labs in low resource environments have either no or inadequate chemical inventory
 - Lack of understanding of the need
 - Commercial solutions inadequate / unattainable
- A lack of inventory can present a dangerous situation

Solution Requirements

- Affordable
 - Low to no cost, ideally
- Promotes chemical security best practices
 - Access control
 - Tracking of chemicals of concern
- Provides economic/research benefits
- Easy to use
 - Laboratory staff have limited capabilities
 - Need to span generations
- Limited infrastructure requirements
 - Compatible with older hardware/software



Chemical Management System (CMS®)

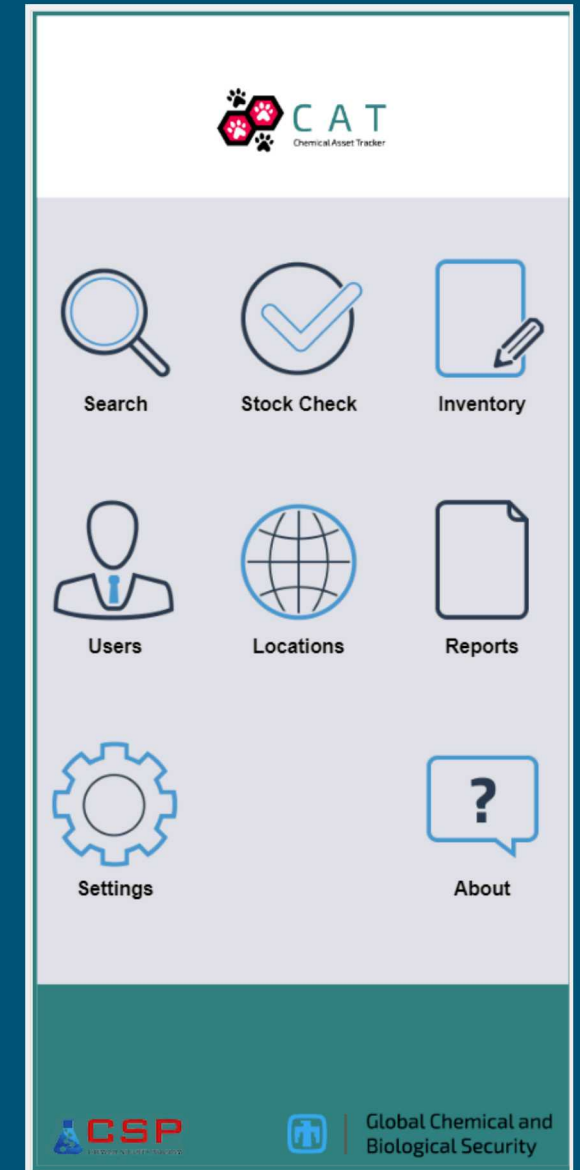
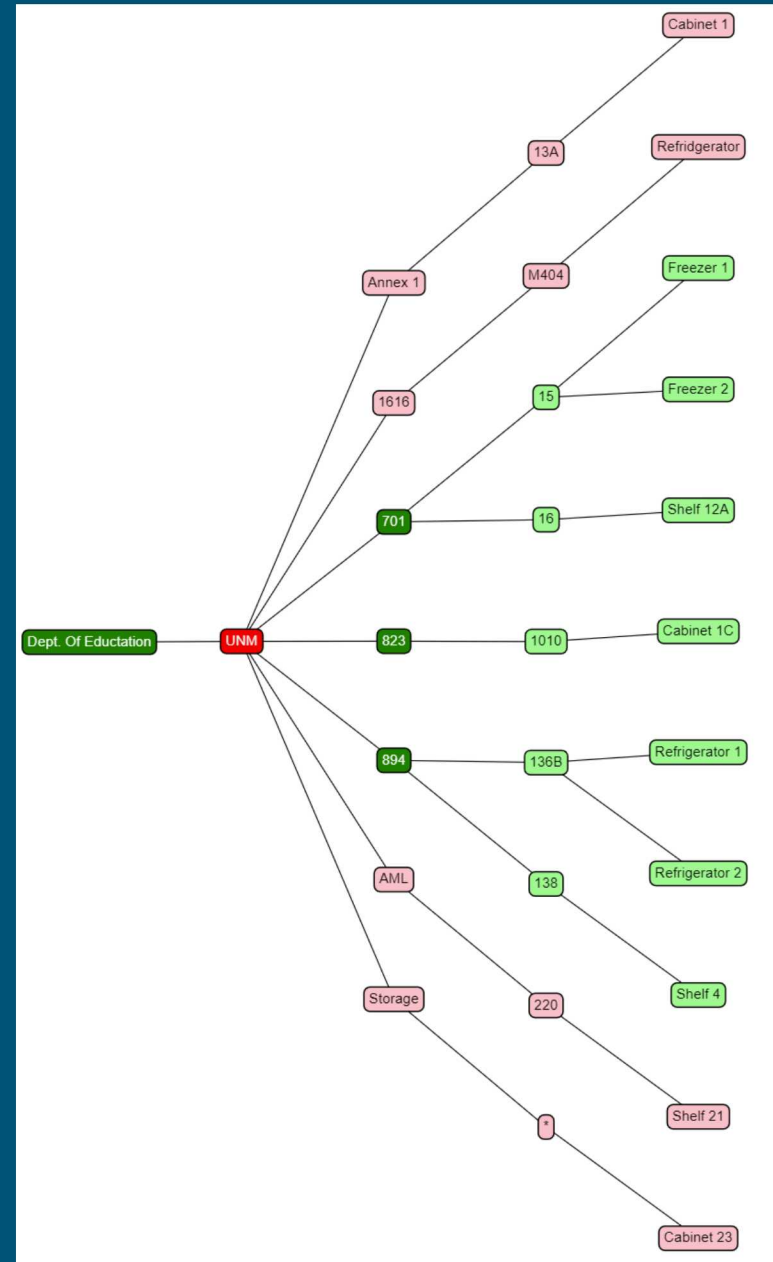
The screenshot displays the CMS application window with the following components:

- Menu Bar:** File, Help
- Navigation Icons:** Search (highlighted), Inventory, Reports, Stock Check, Import, Manage Users, Settings
- Search Criteria Section:**
 - Barcode:
 - Location:
 - Name:
 - Buttons: Clear, Search
 - CAS #:
 - Buttons: Previous, Next
- Search Results Section:**
 - Barcode:
 - Name:
 - CAS:
 - Location:
 - Date In:
 - Expiration Date:
 - Storage Group:
 - Bottle / Container:
 - Remaining Quantity:
 - Units:
 - State:
 - SDS:
 - Owner:
 - Alerts:
 - Security** (Red background)
 - Health Hazard** (Blue background)
 - Physical Hazard** (Yellow background)
 - Checkboxes for Alerts:
 - CWC
 - Theft
 - Other
 - Carcinogen
 - Health Hazard
 - Irritant
 - Acute Toxicity
 - Corrosive
 - Explosive
 - Flammable
 - Oxidizer
 - Compressed Gas
 - Other
 - Notes:
- Status Bar:** Ready, Zoom:

- Free to use/disseminate
- Managed by SNL for the USG
- Easy to use – icon and picture-based
- Access control
- Focus on chemicals of concern
- Barcode readers/scanners
- Reports
- Change history

Next Steps

- Creation of Chemical Asset Tracker (CAT)
- Networked version
 - Allows multiple simultaneous users
 - Hosted on an institution's server
- Mobile version
 - Tile format
 - Can utilize mobile device camera as barcode reader / scanner
 - Integrated with main networked version



What Else?

Risk Mitigation Tools

Sample Transport

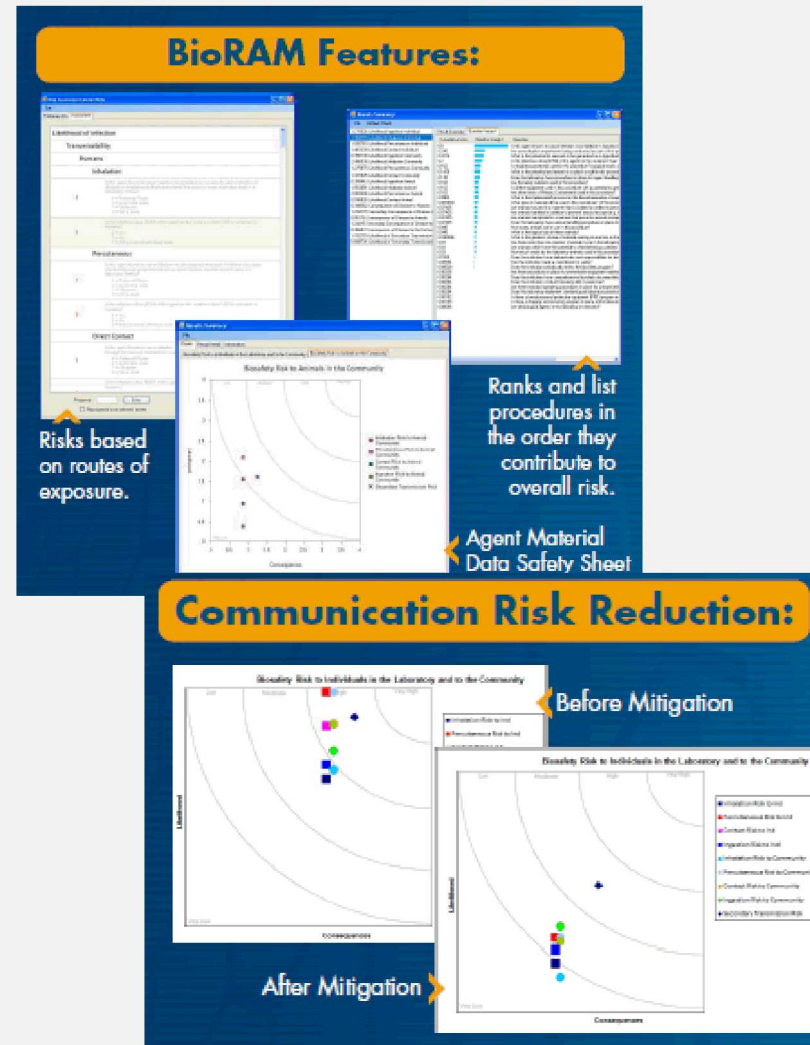
PREP

Improvised PPE



What Else?

Risk Mitigation Tools



Vision

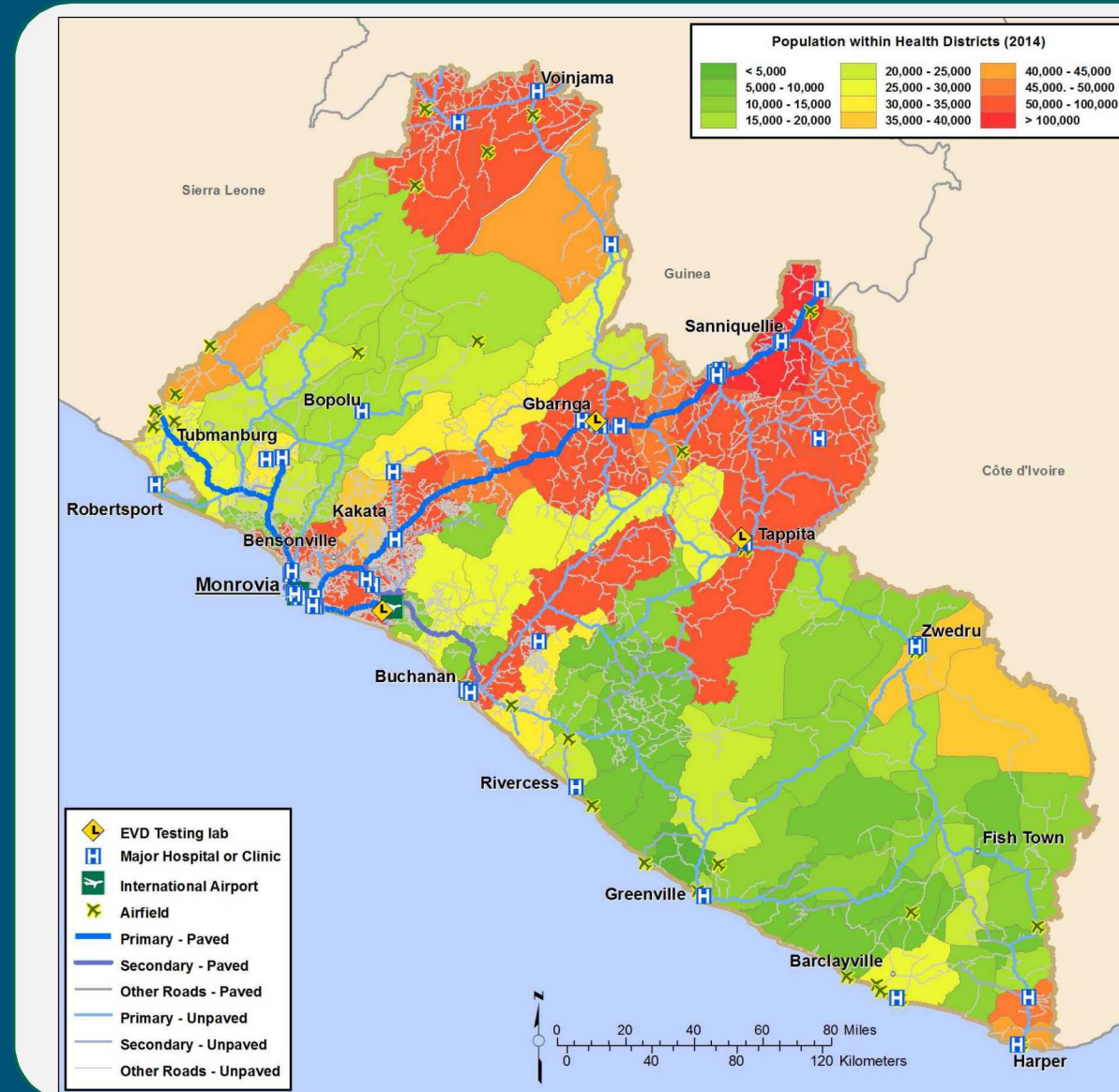
- Create standardized approaches to risk assessment for chemical and biological safety and security
- Create a tool for understanding prioritization and communication

The Tools

- Biosafety RAM
- Biosecurity RAM
- Chem SAM

What Else?

Sample Transport



Liberia

Assistance during Ebola outbreak in West Africa

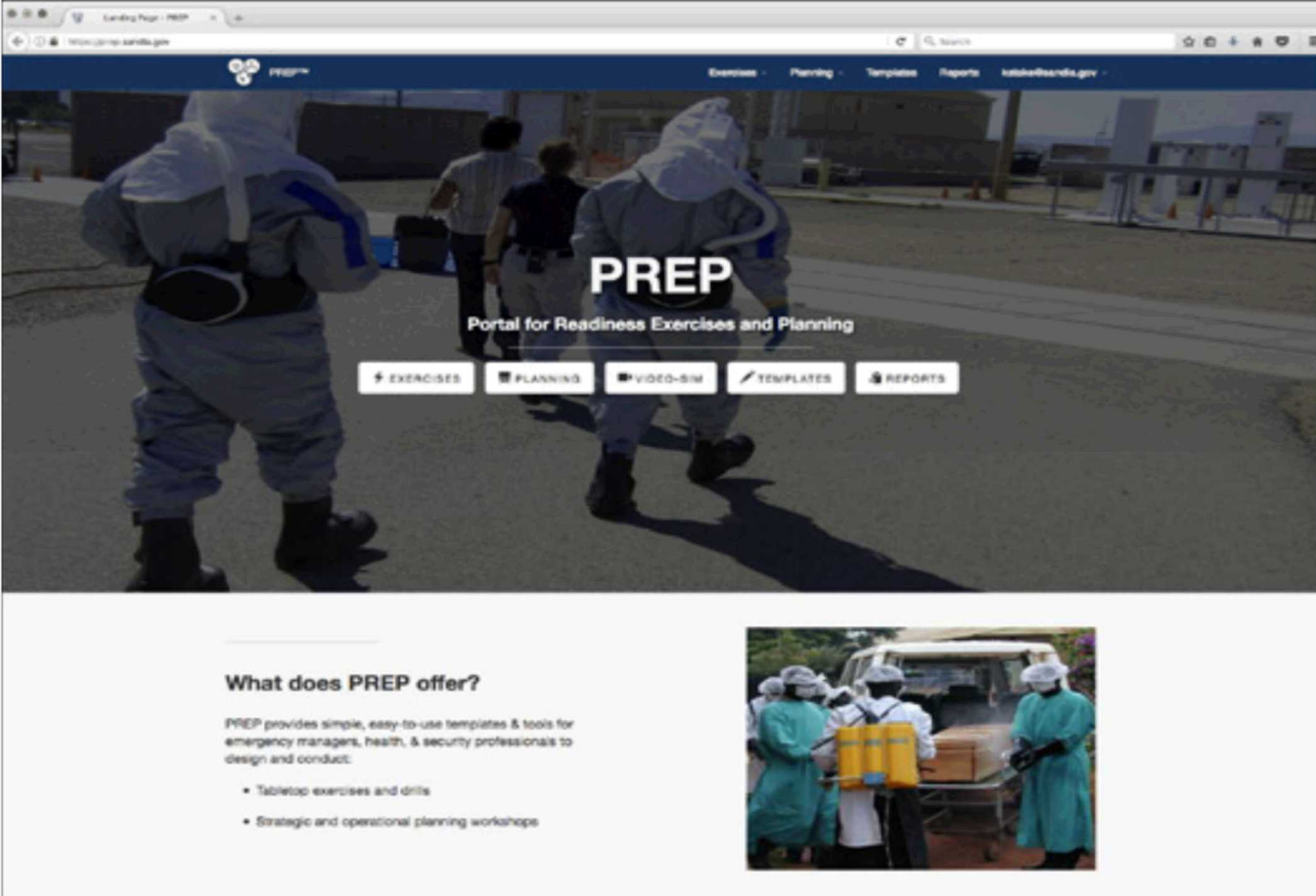
Leveraged existing lab capabilities in geospatial analytics, optimization research, and simulation to develop a model

- optimize the sample transportation system
- inform lab placement

What Else?

PREP

PREP™ Portal for Readiness Exercises and Planning



What does PREP offer?

PREP provides simple, easy-to-use templates & tools for emergency managers, health, & security professionals to design and conduct:

- Tabletop exercises and drills
- Strategic and operational planning workshops

Customized
Scenarios

Online AND In-
Person Usability

Instant After-
Action-Reports
(AAR)

What Else?

Improved PPE



- What common materials could be used in an emergency to provide some protection against CW?
- Need both a scientific basis for selection and promotion *and* to put thought into dissemination of information

<https://www.presstv.com/Detail/2018/09/12/573950/Syria-militants-kidnap-kids>

Take Away

- The solution space that is going to keep the United States safe is broad – both in terms of the aspects of terrorism that need to be addressed but also in the solutions developed
- Our role in cooperative threat reduction gives us insight into challenges that our overseas partners face
- We have been able to help our partners address some of their challenges with innovative, sustainable solutions designed for their needs/environments



Questions?

Peter Hotchkiss

Sandia National Labs

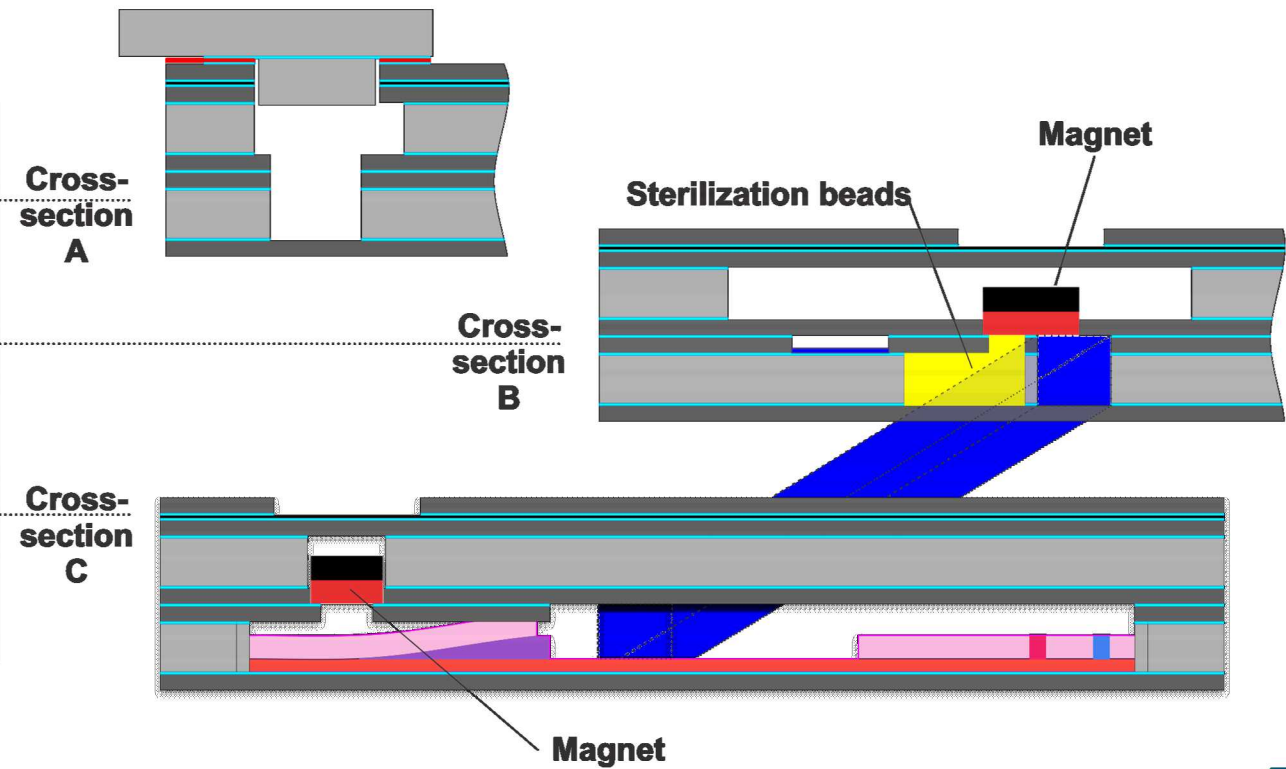
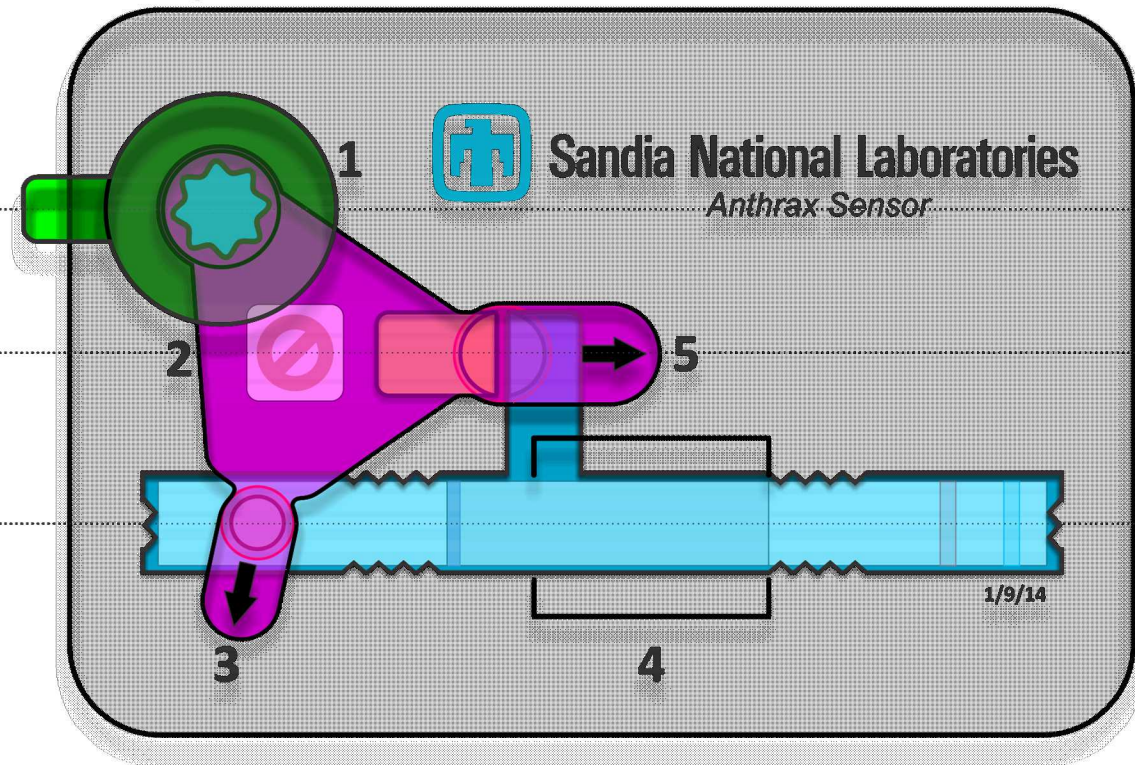
pjhotch@sandia.gov

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Backup

Cartridge Dimensions: 0.25 in. x 1.875 in. x 2.75 in.

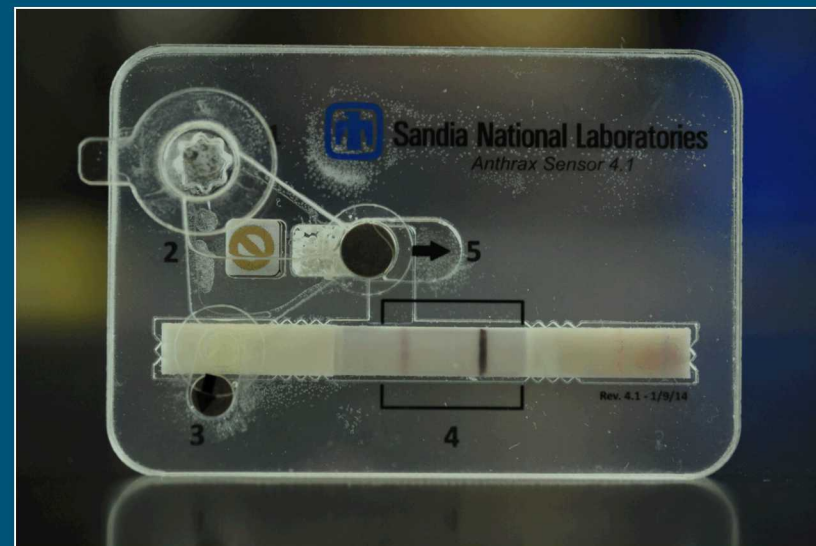


BaDx: Lateral Flow Assay

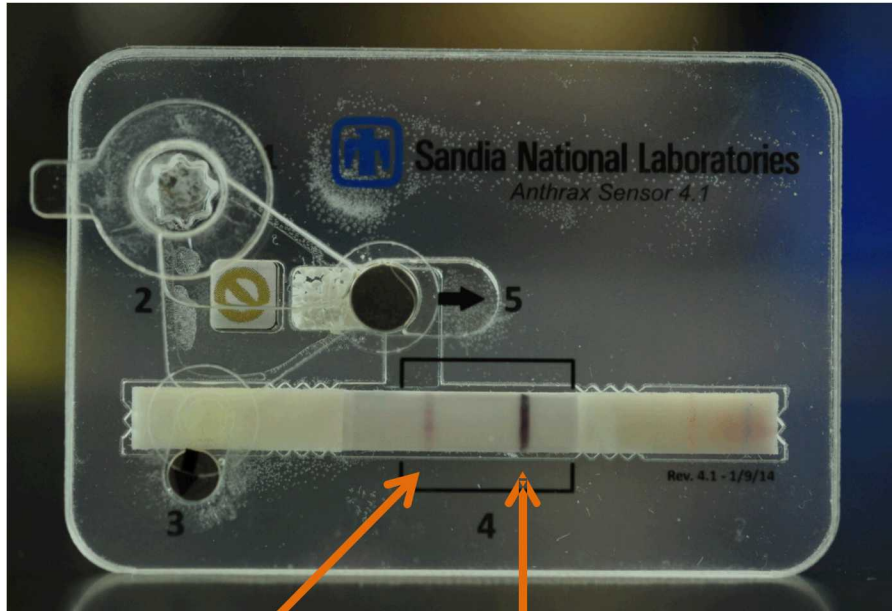
Lateral Flow Assay is commercially available from Tetracore®

- *B. anthracis* has three main virulence factors: protective antigen, edema factor, and lethal factor
- Tetracore LFA detects a protein that is not selective for virulent strains of *B. anthracis*

Sandia based strip was under development and aimed to targeting two virulence factors: lethal factor and protective antigen



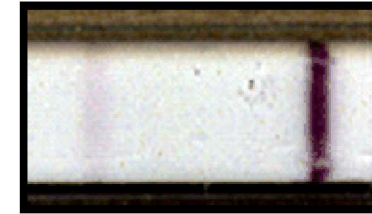
Detection from 100 Spores *B. anthracis*



B. anthracis
Detected

Assay
Control

Sterne (BSL 2)



Ames (BSL 3)



100 spore inoculum, 37°C, no agitation
24 hr culture + 15-60 min. development
Tetracore Red-Line LFA strip

- ***This is a 4-5 order of magnitude improvement in detection limit over LFA alone***
- ***Brings the device detection limit within a practical range for real-world samples***

BaD_x: Future Applications

Device platform can be modified to detect other bacterial pathogens

- Food borne pathogens: *E. coli*, *Shigella*, *Salmonella*, *Campylobacter*
- Nosocomial infections: *Staphylococcus*, *Proteus*, *Clostridium difficile*
- Antimicrobial sensitivity testing for the above pathogens
- *Burkholderia pseudomallei*

Device platform can be modified to serve a safe and secure method for shipping dangerous samples to reference laboratories

- Current shipping containers are costly and can be cumbersome
- Require special training for packaging and shipping