DTRA and Future Directions for Nuclear Detection R&D

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DTRA and Future Directions for Nuclear Detection R&D

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Agenda

- DTRA History and Overview
- Evolving Landscape and R&D Impact
- Nuclear Technologies Technology
- Questions

Agency Evolution

2016
Joint Improvised-Threat Defeat Organization Integrated

1998
DTRA Established

- *Sustain nuclear deterrent*
- *Growing nonproliferation and counterproliferation mission*
- *Increased Arms Control Implem/Verif*
- *Rapid capability delivery*
- *Chemical and Biological Defense*

→ ***WMD Terrorism, Counter Improvised Threats***

1996-1998
Defense Special Weapons Agency

- *Post-Cold War environment*
- *Joint Science Programs, munitions effects, hard targets*
- *Nuclear Stockpile Stewardship*

→ ***Non-nuclear development, WMD Nonproliferation***

1971-1996
Defense Nuclear Agency

- *Operational Support*
- *Cooperative Threat Reduction Initiated*
- *End of Nuclear Testing*

→ ***Counter-proliferation, Arms Control Implementation/Verification***

1959-1971
Defense Atomic Support Agency

- *Nuclear effects research and testing*
- *Force modernization*
- *Limited Test Ban Treaty*

→ ***Research, Modeling***

1947-1959
Armed Forces Special Weapons Project

- *Weapon custody*
- *Operational Storage*
- *Weapons Effects Testing*

→ ***Deterrence, Survivability***

1941-1947
Manhattan Engineering District

- *Initial atomic weapons program*

→ ***Weapons Development***

The Agency evolved over 75 years to incorporate additional missions and complexity that directly impact U.S. national security and combat support to the warfighter

UNCLASSIFIED

Agency Mission

The Defense Threat Reduction Agency enables DoD, the U.S. Government, and International Partners to counter and deter Weapons of Mass Destruction and Improvised Threat Networks

Research & Development: Mission and Vision

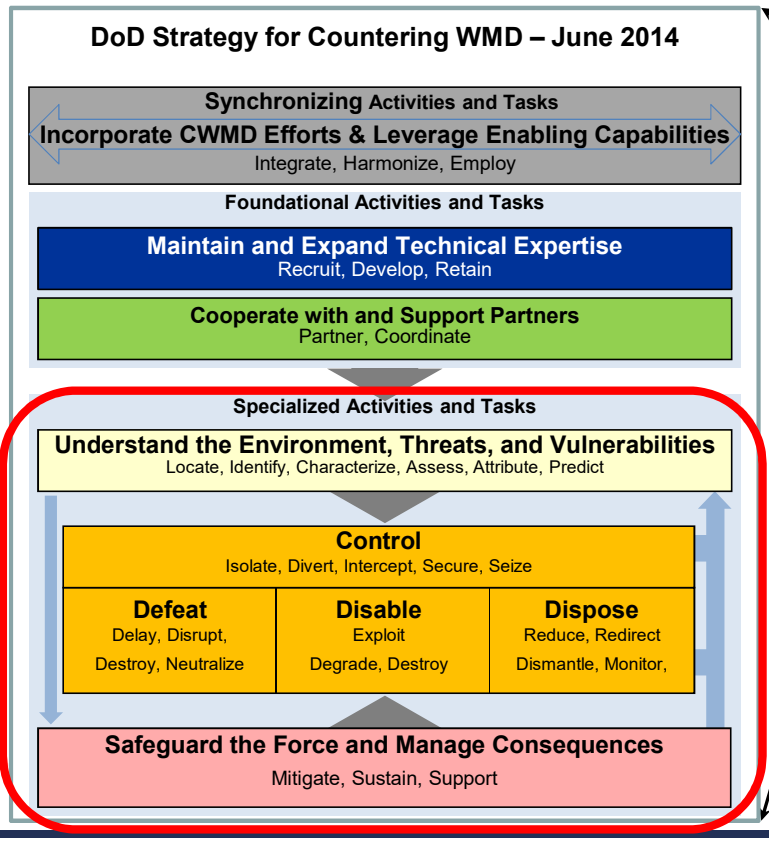
Mission

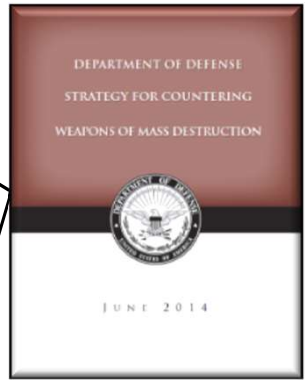
Provide science, technology and capability development investments that maintain the U.S. military's technological superiority in countering weapons of mass destruction & asymmetric threats, mitigate the risks of technical surprise and respond to the warfighter's urgent technical requirements.

Vision

Be the recognized leader for technical innovation to counter weapon of mass destruction & asymmetric threats – responding to urgent warfighter needs while investing in R&D to shape the Nation's counter-threat capabilities.

DTRA R&D Portfolio Aligns with DoD Strategy for CWMD





CWMD S&T Strategic Objectives*

- Understand the Environment, Threats, and Vulnerabilities
- Control, Defeat, Disable, and/or Dispose of WMD Threats
- Safeguard the Force and Manage Consequences

** S&T for Strategic Deterrent is included in these objectives*

DTRA R&D prioritizes *Deter*, *Detect* and *Defeat*

OBJECTIVE	R&D Thrust Areas*	*Capabilities and technologies that…*
Understand the Environment, Threats, and Vulnerabilities	Detect, locate, identify, and track chemical, biological, nuclear, and improvised threats	
	Enhance warfighters' ability to rapidly capture, catalogue, link, and illuminate nefarious activities	
	Increase understanding through high-speed information processing, M&S, and advanced analytics	
	Detect improvised devices (including IED and UAS) and their components from safe distances	
	Improve nuclear/radiological hazard assessment techniques, methodologies, and analytic tools	
Control, Defeat, Disable and/or Dispose WMD and Improvised Threats	Provide direct or indirect physical or functional defeat of WMD threats, especially prior to weapon use	
	Prevent adversary networks' ability to deliver and use IEDs, or rapidly neutralize emplaced IEDs	
	Interrupt the acquisition of weapon-related materials and expertise, or otherwise defeat threat networks	
	Enable suitable, field-deployable capabilities to mitigate warfighter risk through improved stand-off	
	Support survivable, hardened conventional forces that can fight and win in a difficult WMD environment	
Safeguard the Force and Manage Consequences	Protect forces, reduce casualties, and degrade adversaries' abilities to disrupt operations	
	Enable biological, chemical, and radiological surveillance, exposure detection, and medical diagnostics	
	Provide survivability standards, hardening technologies, and experimental test capabilities	
	Improve medical countermeasures, pretreatments, prophylaxes, vaccines, and therapeutics	
	Reduce size and weight, and increase performance of contamination mitigation tools	

* ***Not all R&D*** **Thrust Areas** ***are listed***

An Evolving Threat Perspective

Cold War

Post-Cold War

Post-9/11

Present

U.S. view of nuclear threats

- Great power competition – reemergence of long-term, strategic competition by China and Russia
- Rogue regimes destabilizing regions through their pursuit of nuclear weapons or sponsorship of terrorism
- Terrorists, trans-national criminal organizations, and other malicious non-state actors

DPRK Salvo Launch

Russian Iskander Short-Range Ballistic Missile

DPRK Nuclear Warhead News Conference

Russian Gazelle ABM Missile

Chinese DF-26 "Carrier Killer" missile

National and nuclear policy has changed dramatically

Nuclear terrorism greatest threat	→	*Great power competition*
Nuclear weapons going away	→	*Nuclear weapons critical role*
No new nuclear capabilities	→	*Must develop new nuclear capabilities*
No nuclear testing	→	*Will resume nuclear testing if necessary*
Nuclear weapons for deterrence only	→	*Fight and win if deterrence fails*

Key Tenets of the National Defense Strategy

Security Environment

- Complex & volatile environment
- Great power competition
- Eroding U.S. military advantage

Adversaries

- Russia, China (revisionist)
- North Korea, Iran (rogue)
- Non-state actors

Levels of Conflict

- Strategic Armed Conflict
- Conventional Armed Conflict
- Great Power Competition

Defense Priorities

- Strong Nuclear Deterrent
- Decisive Conventional Force
- New Approaches to Compete Below Armed Conflict

RD-NT: Nuclear Technologies

Mission – Develop technologies that enable an effective nuclear deterrent, the capabilities to counter nuclear threat networks, and fight and win on the nuclear battlefield

Nuclear Weapon Effects

- Modeling & simulation tools for nuclear targeting and consequence of execution assessment
- Use existing test data to certify new nuclear capabilities without nuclear testing

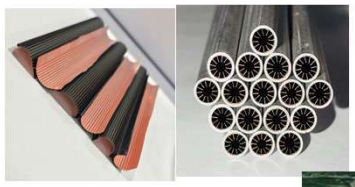
Cratering

Fallout / Fireball / Blast / Thermal

M&S to enable planning, training, and requirements definition

Nuclear Threat Detection

- Sensors for characterization of the nuclear battlefield
- Technologies to collect, analyze, exploit, and attribute nuclear detonation data and signals



Boron-coated straws increase neutron sensitivity

Standoff Radiation Detection enables nuclear battlefield situational awareness

Nuclear Warfighting Dominance

- Test concepts, capabilities, and plans through rigorous assessment and wargaming
- Integrate wargaming tools into exercises
- Enable DoD forces to render safe nuclear threats under battlefield conditions

Nuclear Survivability

- Develop nuclear environments, protection standards, and handbooks
- Operate large pulsed-power machines to produce intense bursts of radiation simulating a nuclear weapon
- Mission-critical systems analysis to characterize nuclear survivability shortfalls

Large Blast Thermal Simulator at WSMR

Navy Electromagnetic Pulse Simulator at Pax River

“The NTD Rules”

1 - No Helium-3 

2 - No cryogenic cooling 

3 - All detectors developed by NTD will be networkable through MFK-TAK

4 - No active interrogation R&D for wide area search 

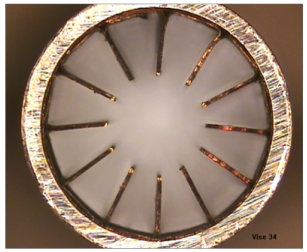
Boron-Coated Straws

- Proposed boron-coated straws (BCS) are a low-cost alternative to high cost (limited supply) ^{3}He gas,
- BCS introduces many innovations, including inner coated walls (septa) to increase detection efficiency, and achieve higher count rates, with lower dead times.
- BCS is a reliable technology, successfully applied to other applications, including portal monitors (DNDO), neutron imaging (DOE), and handhelds (DARPA SIGMA)

Pie6 Straw

100% more $^{10}B_4C$ coating compared to round BCS (same diameter)

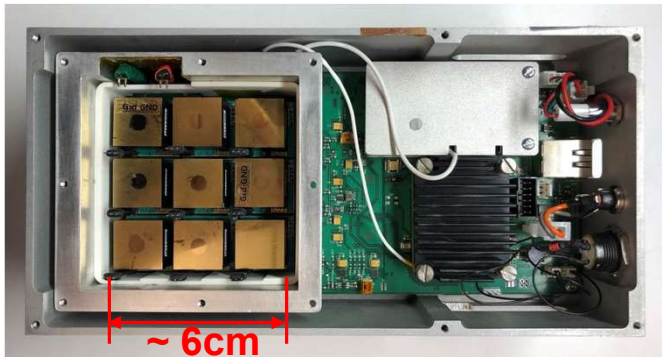
Pie12 Straw

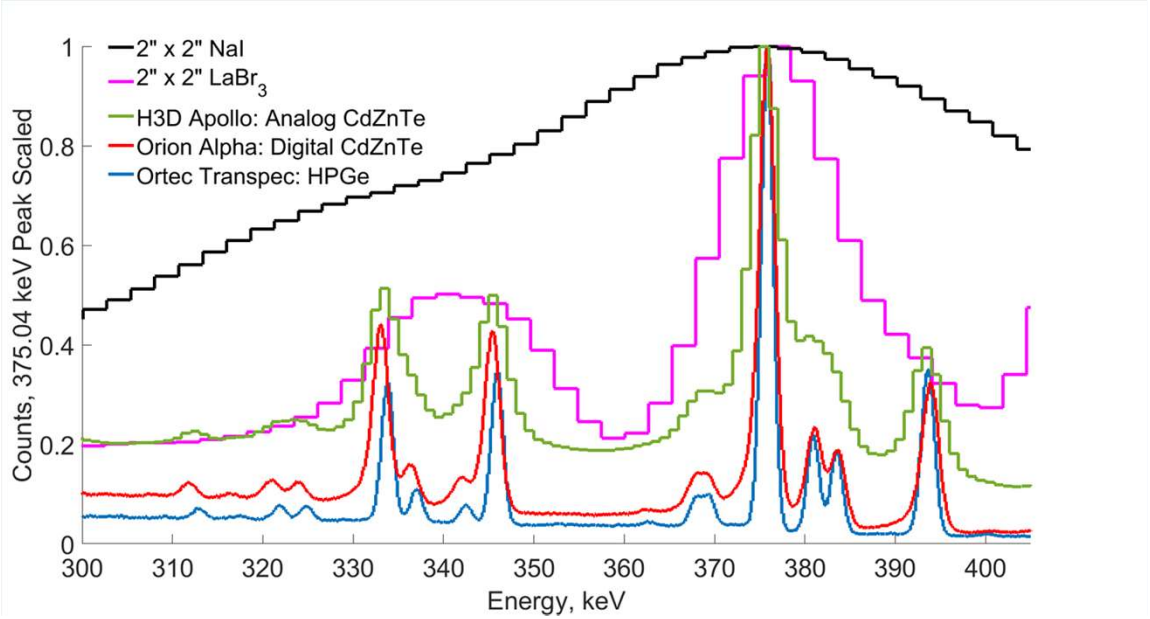


200% more $^{10}B_4C$ coating

Room Temperature High Resolution

- Near HPGe resolution
- 3 keV FWHM at 662 keV
- Modular detector design
- Imaging capable
- Commercial transition (H3D Inc)





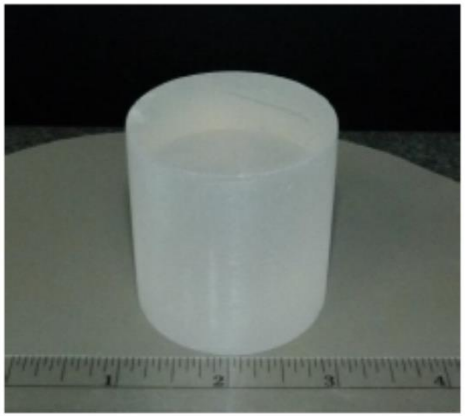
9 detector spectra all events

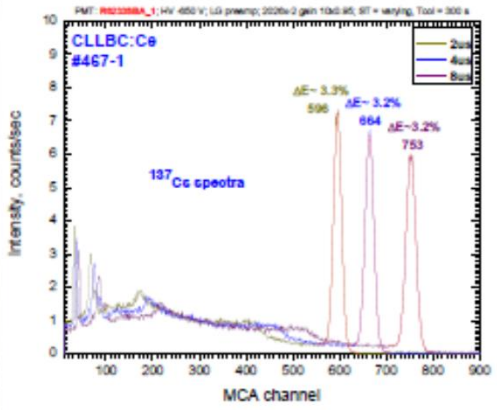
Elpasolite dual mode scintillators

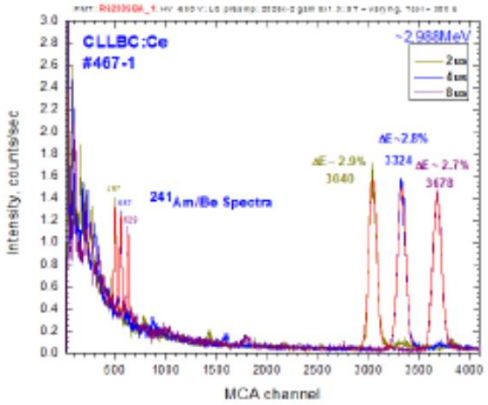
∅2" x 2" CLLBC

Cs-137 3.2% @662keV

AmBe 2.8% @2.99MeV







1. CLLBC ∅2"x2"
2. Cs-137 gamma response:
   3.2% @ 662keV
3. AmBe neutron response:
   2.8% at 3MeV GEE
4. Packaged with PMT and electronics

MERLIN / VIPER

Developmental Testing at System level used to provide rapid feedback to multi-performer team.

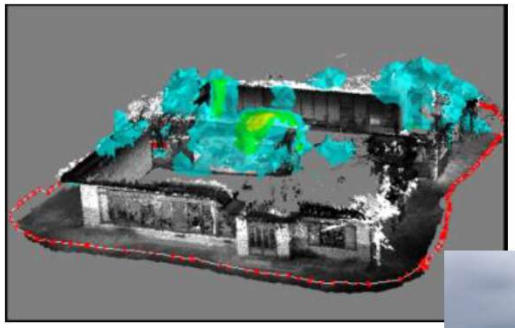
Began with HMMWV in parking lot and engineers.

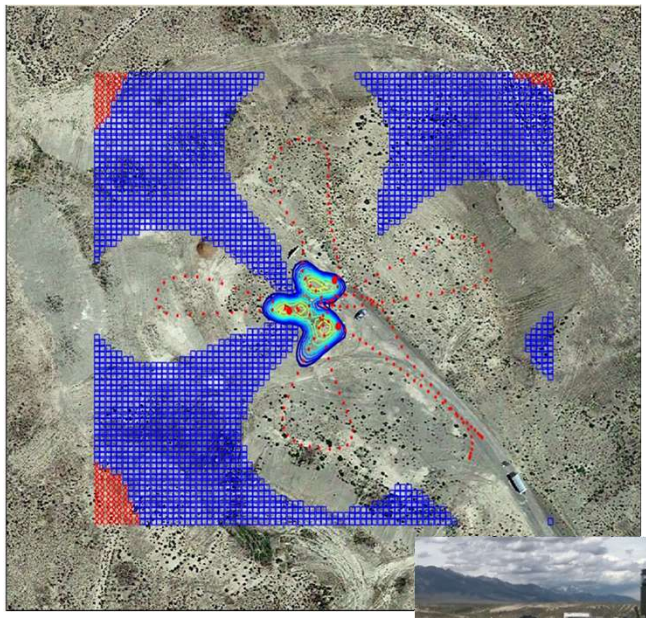
Finished with NBCRV integration and active duty operators.

Transitioned to JPEO-CBRN in 4QFY18

Rapid Radiation Mapping

3D scene data fusion



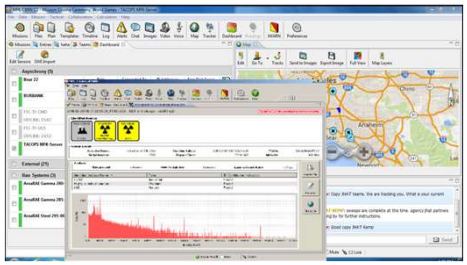


Large area surveyed quickly (3 minutes)

CBRN Situational Awareness

Why are MFK-CBRN and TAK-RN needed?

- DoD Forces must be prepared to operate on a contaminated environment
- CBRN operators lacked a basic communications system for sharing CBRN threat and hazard information
- When seconds count, operators had to physically bring sensors to the tactical operations center for data download and sharing



Mobile Field Kit – Chemical, Biological, Radiological, and Nuclear (MFK-CBRN)

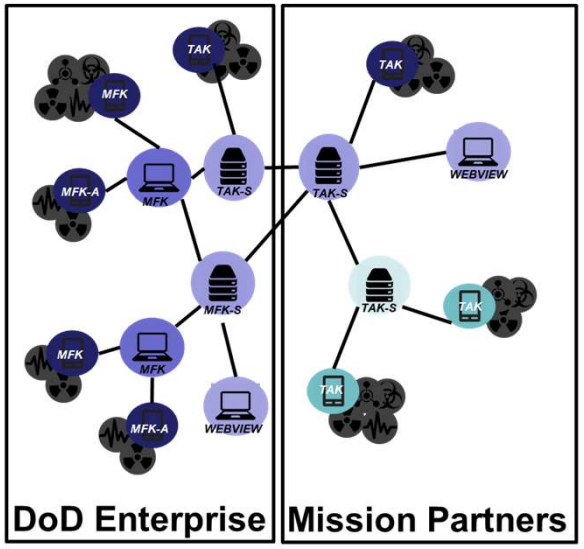
Tactical Assault Kit – CBRN (TAK-CBRN)

Enhance, inform and expedite CBRN threat or hazard notification and decision making at all levels

How Will It Do It

MFK and TAK are Robust and Reliable Systems

- Government off-the-shelf (GOTS) Software
- Commercial off-the-shelf (COTS) Hardware
- Open Sensor Standards
  - 40+ with new sensors and detectors added based on user needs
  - Types: CBRN sensors, biometric sensors, and any user specific sensors requested
- Network Agnostic
  - Tactical Radio
  - Cellular
  - Satellite



For the Warfighter, With the Warfighter

Developed with user feed-back for every application

- Agile development process to incorporate operational lessons learned with software engineers in the field
- Pilot effort with five WMD-Civil Support Team
  - Washington D.C., Massachusetts, Hawaii, Southern California, and Missouri
- Partnership with the 20th CBRN Support Command
- Participation in over 20 National Security Special Events
  - Boston Marathon, Presidential Inauguration, July 4th Celebrations, MLB All-Star Game, etc.
- State and National Level Exercises
  - BAYEX, Vigilant Guard, etc.
- Bi-annual Community of Interest meeting

DTRA RDT&E Summary

- DoD's R&D organization focused on CWMD and Counter-Improvised Explosive Devices and Counter-Improvised Threats
- Responds to national and DoD CWMD priorities
- RDT&E base provides CWMD and Counter-Improvised Explosive Devices and Counter-Improvised Threats combat support directly to our warfighters
- Integrated/coordinated with DoD, Interagency, and international partners
- Develops and operates unique and essential CWMD and Improvised Threat test capabilities
- Comprehensive R&D investment increases agility to respond to new/changing Combatant Command counter threat requirements

Questions