DTRA Research and Development in Nuclear Data

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- Nuclear Technologies Overview
- Nuclear Data Research and Development Examples
  - High Altitude Nuclear Environment at University of California Los Angeles (UCLA) Large Plasma Device (LAPD), and Naval Research Laboratory (NRL)
  - Nuclear Data Basic Research at Colorado School of Mines (CSM), and Pennsylvania State University (PSU)
  - Future of Detection Science: Nanomaterials and nuclear data
- Summary

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 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

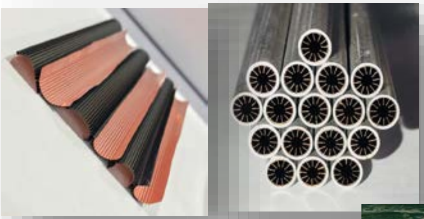
- Modeling & simulation tools for nuclear targeting and consequence of execution assessment
- Use existing test data to certify new nuclear capabilities without nuclear testing

Cratering

Fallout / Fireball / Blast / Thermal

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 Survivability

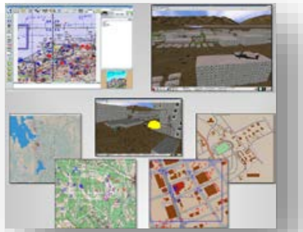
- Develop nuclear environments, protection standards, and handbooks
- Operate large pulsed-power machines to produce intense bursts of radiation simulating a nuclear weapon
- Mission-critical systems analysis to characterize nuclear survivability shortfalls

Large Blast Thermal Simulator at WSMR

Navy Electromagnetic Pulse Simulator at Pax River

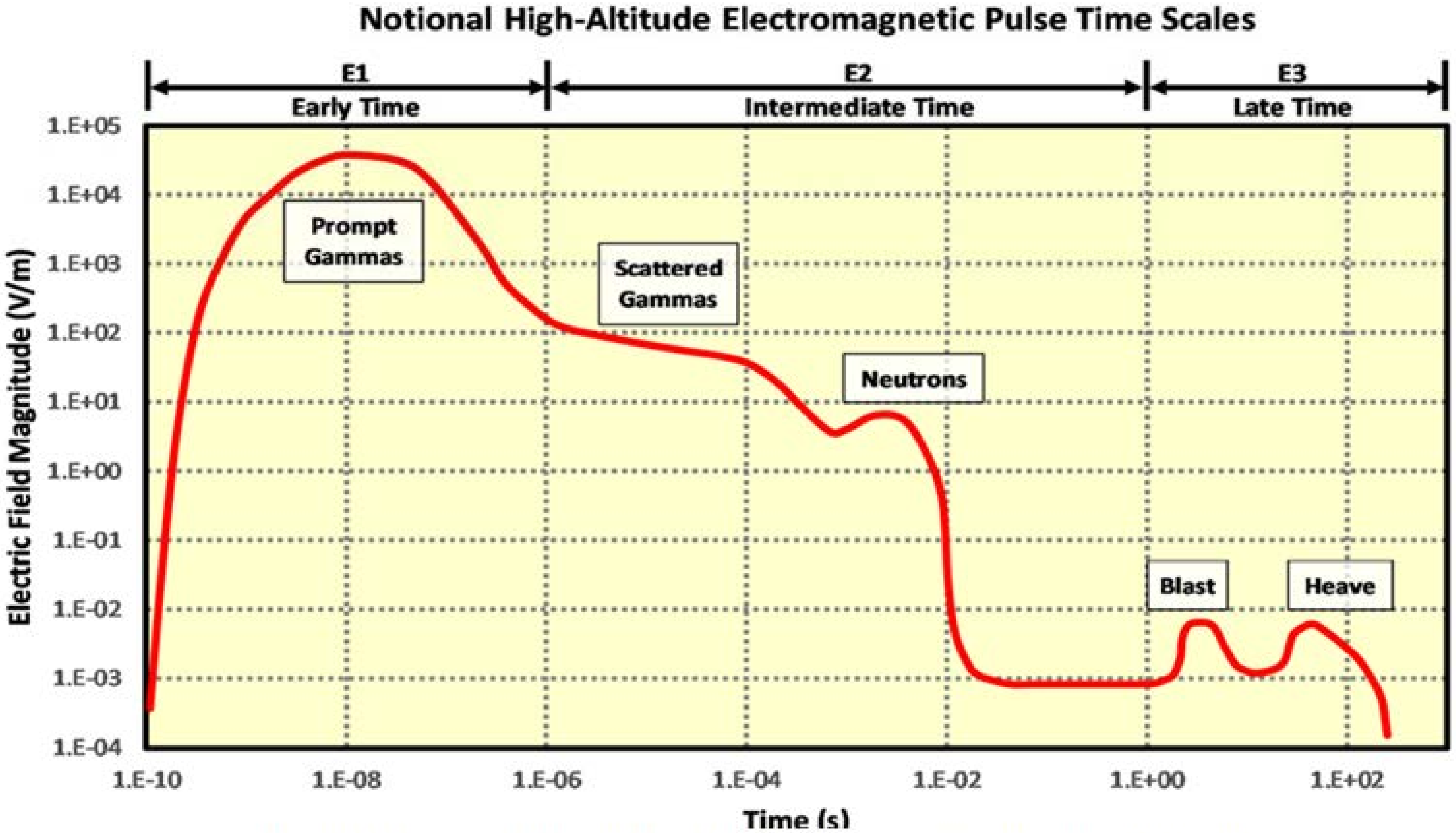
Nuclear Warfighting Dominance

- 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



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

HANE and Nuclear Data



Example timescales for high-altitude electromagnetic pulse (HEMP).

UCLA LAPD Experiments

- Rapidly exploding laser-produced plasmas can be designed to investigate the coupling of energy and momentum between an expanding debris cloud and a magnetized, ambient plasma in the context of HANE
- Scaled laboratory experiments can potentially provide new insight into the physics of HANE
- Laboratory shock experiments are unique in that the ratio between the size of the exploding debris cloud and the debris ion radius is of order unity; details of the coupling physics will affect shock formation, providing a test-bed where the physics of debris-ambient coupling can be studied in detail

Nuclear Data at Naval Research Laboratory (NRL)

- Cross sections for difficult-to-measure excited-state to excited state transitions are required to push plasma chemistry beyond simple weakly-ionized model
- Cross sections for the plasma chemistry from a variety of sources
  - Direct measurements when available
  - Models based on spectroscopic data
  - First-principle quantum-mechanics
- Excited-state to excited-state cross sections can be estimated from a general Thomson expression

DTRA Basic Research: Coupling fission yield measurements and theory

Lead: Colorado School of Mines (CSM)

Objective: To improve the fundamental understanding of the fission process by using experimental and theoretical techniques

Method: Coupling radiochemistry, nuclear engineering and theoretical nuclear physics will enable a coordinated effort to measure and model fission product yields of U-235, Pu-239 and U-233 in varying neutron environments

CSM Fission Yield Research Plan

Experiment

- Update reactor characterization
- Pu-239 reactor irradiations & material preparation
- Continue interpretation of Pu-239 data from the Department of Energy’s Triangle Universities Nuclear Laboratory and Lawrence Berkeley National Laboratory’s 88-inch Synchotron”

Theory

- Characterize Geological Survey Training, Research, Isotopes, General Atomics Reactor (GSTR)
- Coordinate codes to run fuel burnup calculations
- Generate optimized irradiation cells for various neutron spectra
- Interpret Pu-239 Fission Results

DTRA Basic Research: Short-Lived Fission Fragments Characterization & Detection

Lead: Pennsylvania State University (PSU)

Objective: Accurate, fast, post-detonation nuclear forensics non-destructive analysis based on detection of short-lived fission products

Method: Use cyclic neutron activation analysis (CNAA) with tailored radiochemistry to accurately measure independent and cumulative fission yields of ~70 short-lived fission products

Nuclear Detection and Nanomaterials

- Some detection materials contain inherently radioactive constituents

- Detection materials may emerge from basic research that pose degradation challenges

  - Introduction of nanotechnology may introduce new concerns about nuclear interactions within detectors

Potential Research Area for Detector Design: Nanomaterials and Nuclear Data

- Objective: Improved collection and transmission of light from sensing material to electronics
- Better understanding of impacts to nuclear interactions in detector materials
    - Unexpected disruption to nanostructured materials
    - Tailored designs may reduce light output, reducing energy resolution
    - Trace isotopes that may cause damage/ prediction discrepancies
    - Integration of nuclear data, nanodevice, electronics and system design
- Research areas to address nuclear interactions that may degrade nanodevices
    - Nuclear data measurements to predict nanomaterial effects in detectors
    - Advanced nanomaterials may need to consider trace nuclide-radiation interaction effects

Nuclear Data Summary

- Key DTRA nuclear data areas include detection, environments, survivability and warfighter support
- Nuclear technologies research and development contributes to, and uses nuclear data