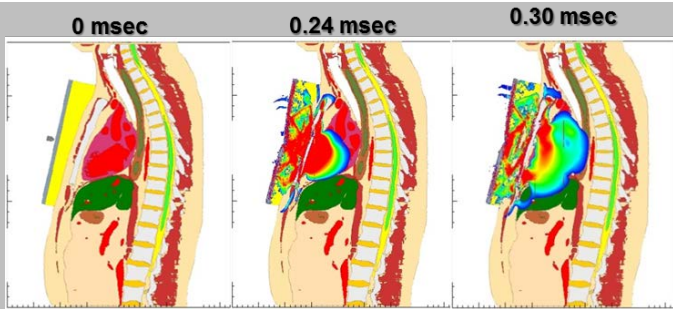
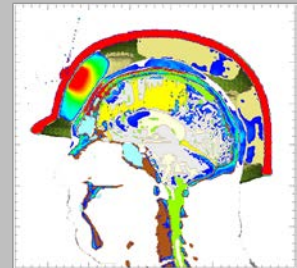


Exceptional service in the national interest



Lethal or NonLethal ?



IMS: Soldier Protection

D. A. Dederman, TBT Manager, dadeder@sandia.gov

Integrated Military Systems Center

Terminal Ballistics Technology

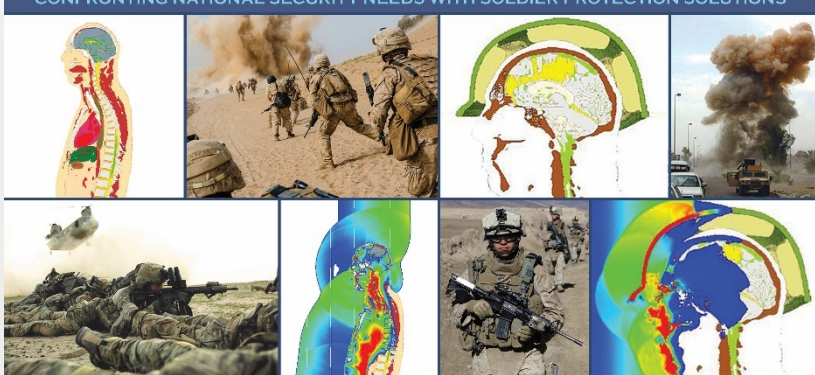


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Military Systems & Technology – Protection Systems


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CONFRONTING NATIONAL SECURITY NEEDS WITH SOLDIER PROTECTION SOLUTIONS




INSULT/INJURY SIMULATIONS FOR IMPROVED EQUIPMENT AND TRIAGE

ANATOMICALLY CORRECT HUMAN MODEL; INSULTS: BLAST (TBI), BEHIND ARMOR BLUNT TRAUMA; DOE COMPUTATIONAL CAPABILITIES; SIMULATIONS: EQUIPMENT ASSESSMENTS & WOUND INJURY MECHANISMS



MILITARY SYSTEMS & TECHNOLOGIES
WWW.SANDIA.GOV/IMS

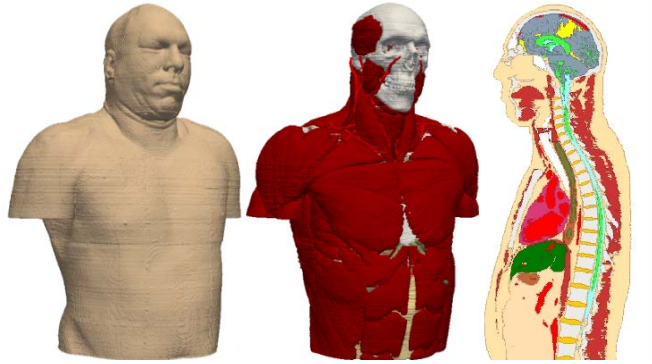


- **Warfighter Human Modeling**
 - Anatomically Correct Model
 - Head, Neck & Torso Insult Simulations
 - Goal: Complete Male & Female Model
- **Warfighter Protection Systems Assess**
 - Equipment (fielded & proposed)
 - Scenario Effectiveness
- **Warfighter Operations**
 - Investigate wound injury mechanisms
 - Scenario Reconstruction

Dismounted Soldier Protection M&S

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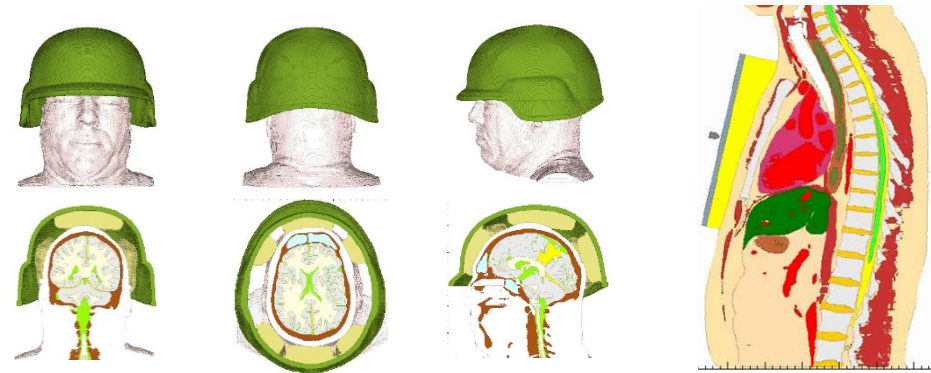
Modeling of the human head-neck-torso



- **High fidelity: 1mm resolution**
- Anatomically correct distribution of **21 distinct materials**
- Each material represented by advanced constitutive material models

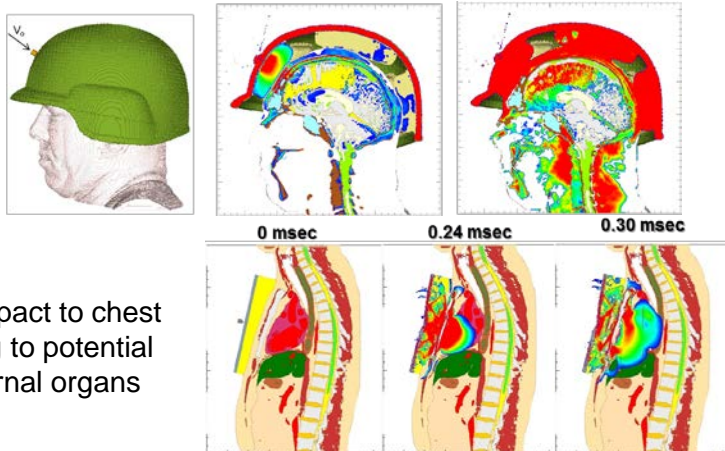
Modeling of Personal Armor

Model deployed, prototype, or notional armor for armor merit assessments



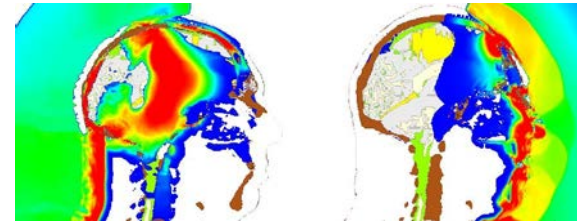
Simulations of non-penetrating projectile impact leading to behind armor blunt trauma (BABT)

Projectile impact to helmet creating intracranial stress waves leading to possible TBI



Projectile impact to chest plate leading to potential injury to internal organs

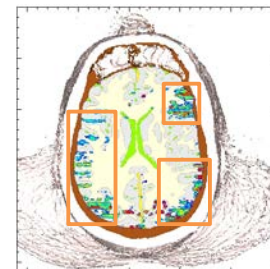
Simulation of intracranial stress waves leading to TBI



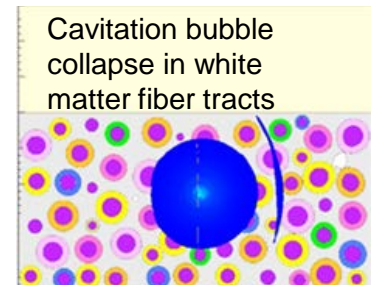
Blast Simulations
 Blast: 13 bars
 Red = 50 bars
 Event Duration: 4 ms

Applying M&S to research TBI mechanisms

Cavitation prediction



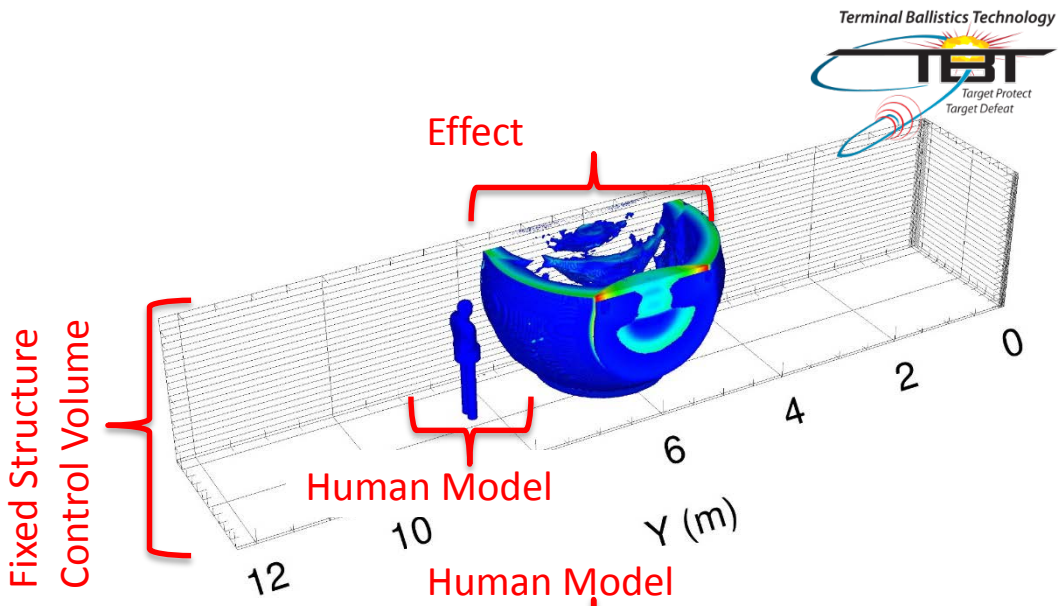
Cavitation bubble collapse in white matter fiber tracts



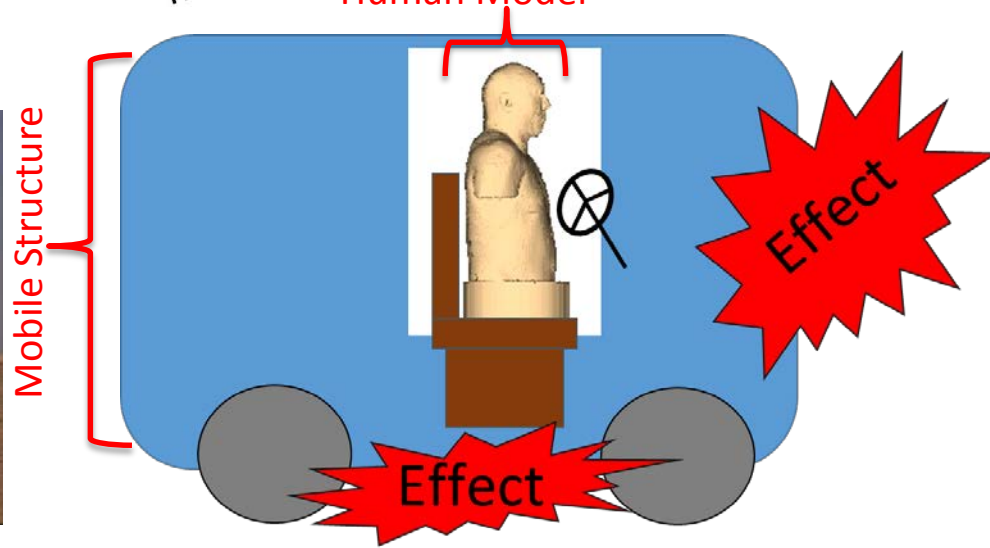
Lethal/Non-Lethal Effects: Fixed and Mobile structures

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Fixed Structures: Bunker Building



Mobile Structures: APV Tank



Summary

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- Developed & demonstrated tools to assist in better protecting the warfighter
- Constructed anatomically accurate digital models of the head/neck/torso region
 - Constitutive models fitted, ongoing refinements based on available data
 - Future work includes development of complete male & female models
- We integrate digitized models of conceptual and prototype armor
- Our numerical simulations enables:
 - Investigation of human response/injury under complex loading environments
 - Design of experiments for equipment effectiveness and wound injury protection

