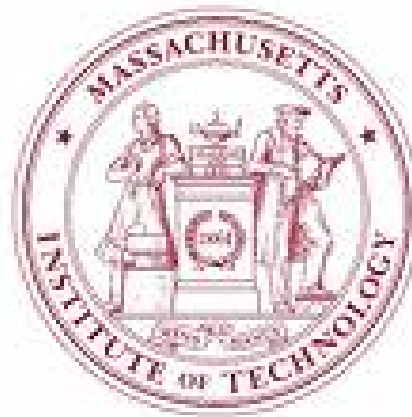


Military Medicine Perspective on the Brain Injury



David F. Moore, MD, PhD
DVBIC/DCoE

Disclaimer



Concussion Biology

- PTA

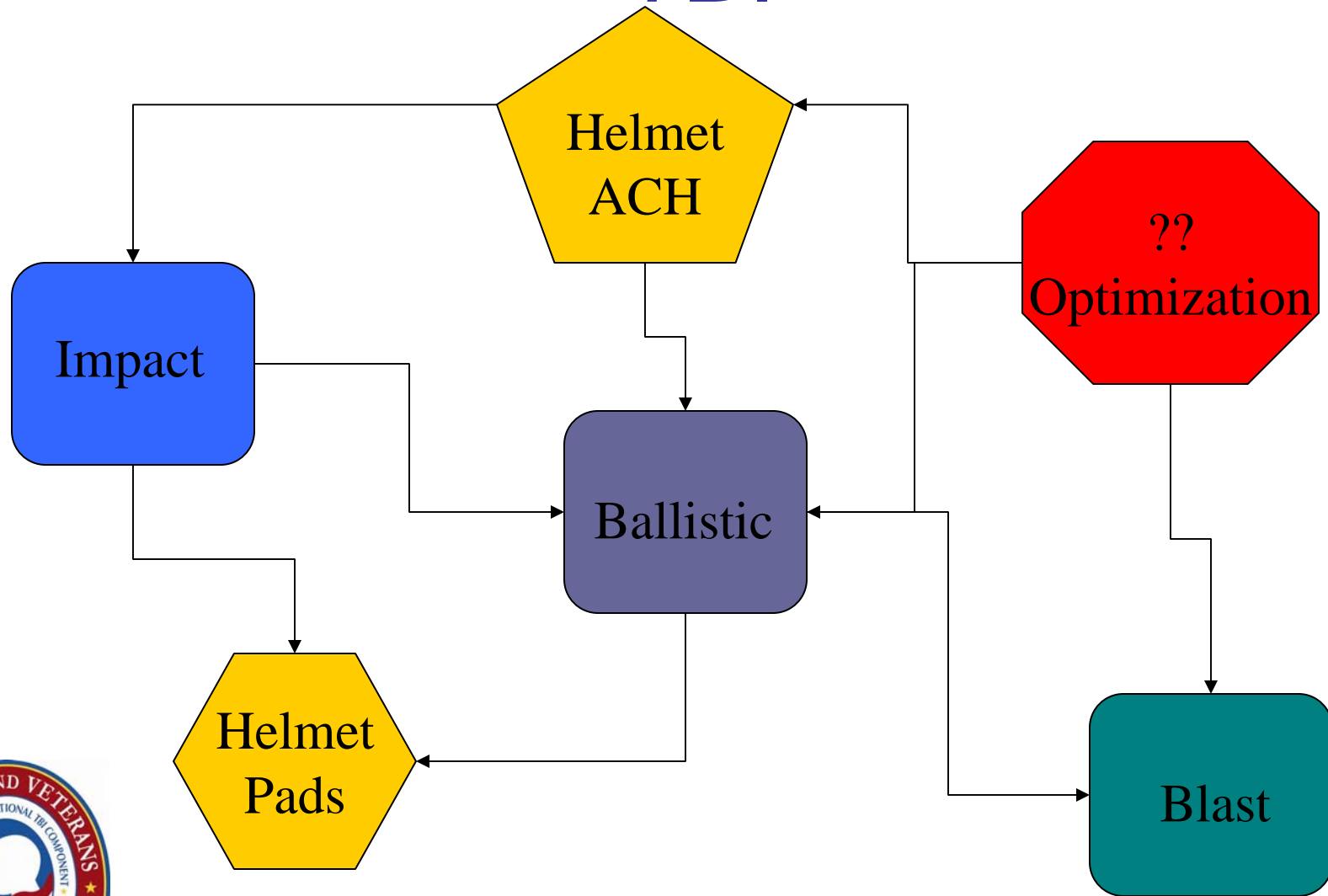
Impact Injury → bilateral process
→ interference with memory encoding →
memory consolidation hypothesis → PTA

- LOC

Impact Injury → paroxysmal
depolarization shift → convulsion → LOC



Strain Rate Continuum of TBI

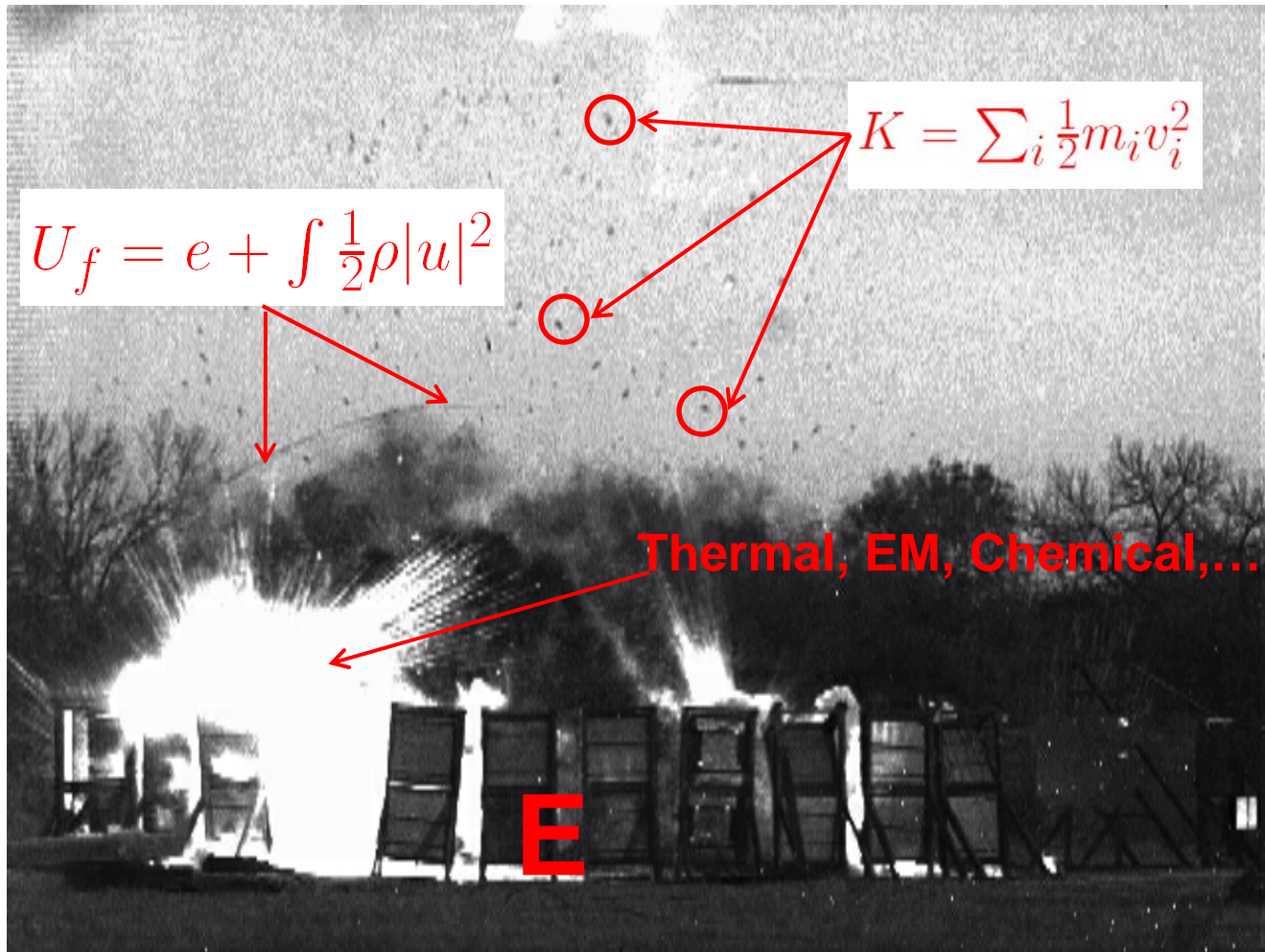


Blast Injury and TBI

- Primary - direct effects due to over-pressurization or under-pressurization
- Secondary - penetrating shrapnel trauma, fragmentation injury
- Tertiary - effect of structural collapse and or person thrown by blast wind
- Quaternary - burns, asphyxia, exposure to toxic inhalants



Energy Transfer - Blast physics





Detonation Effects



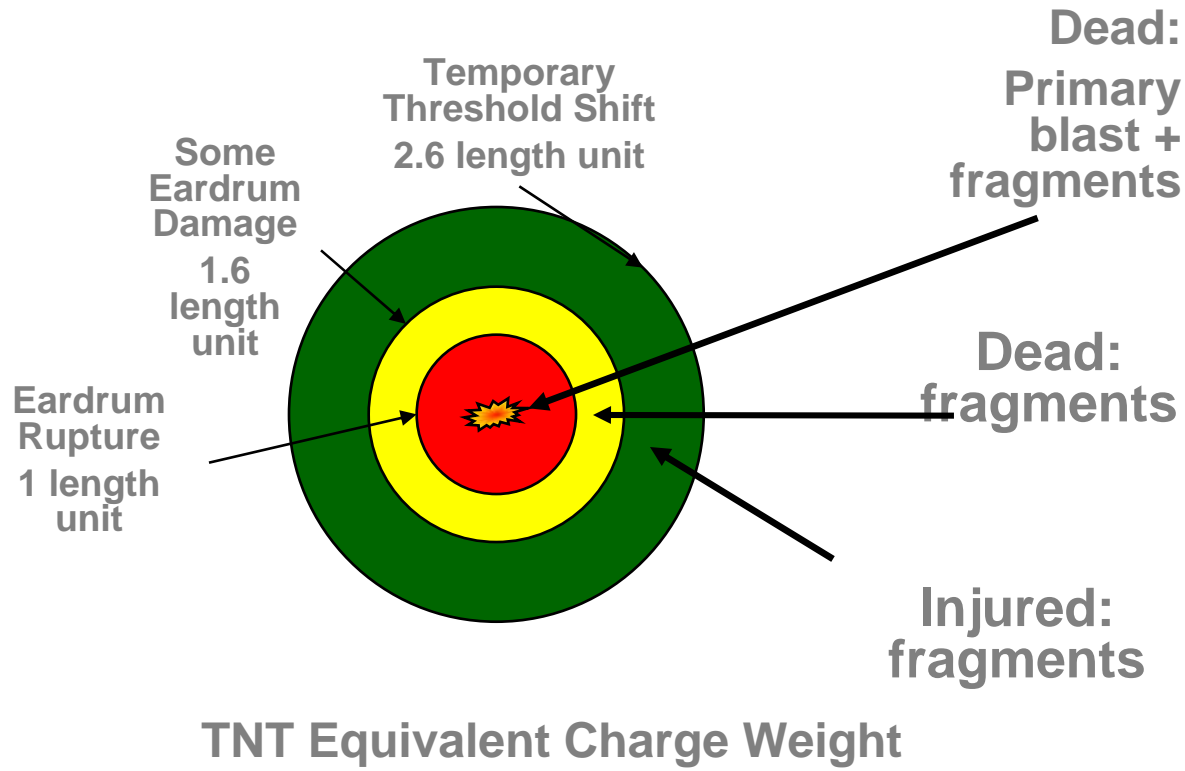


Detonation Effects



Open Space Explosions

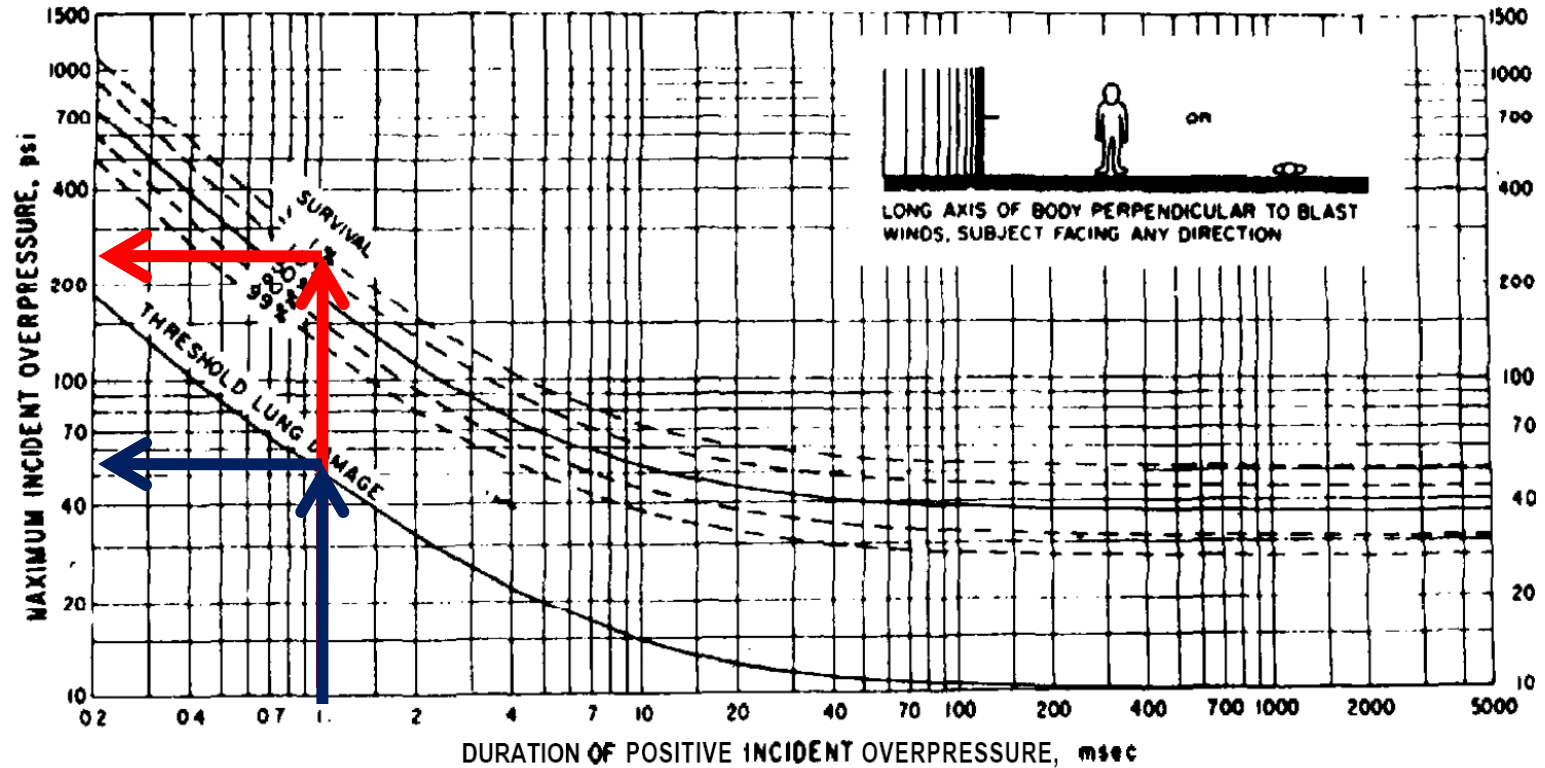
Frame of Reference Debate



DVBIC - MIT Full Head Model



Thorax tolerance to air blast



From: Textbook of military medicine, Part 1, Chapter 7
The physics and mechanisms of primary blast injury

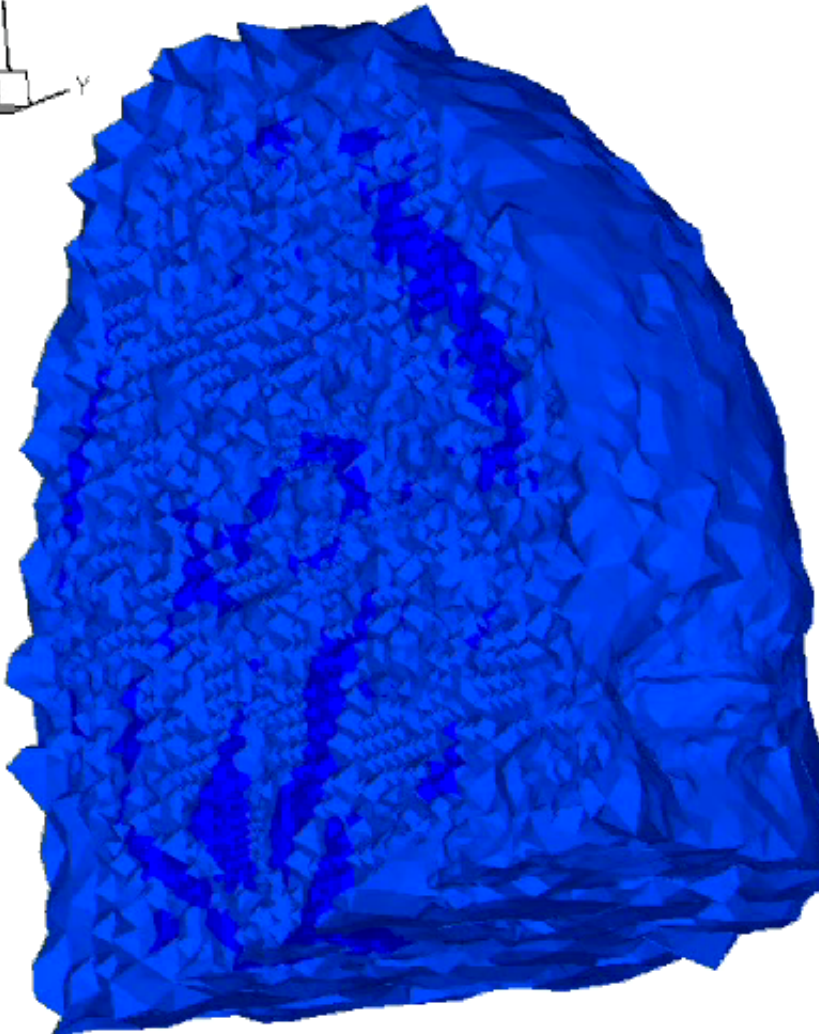
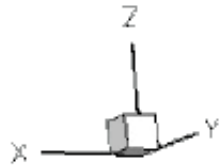
Constitutive models and properties

- Tait EOS for fluid-embedded structures, elastic deviatoric response
- Mie-Gruneisen EOS for bone
- Heterogeneous tissue properties from impact literature
- Viscoelastic effects neglected

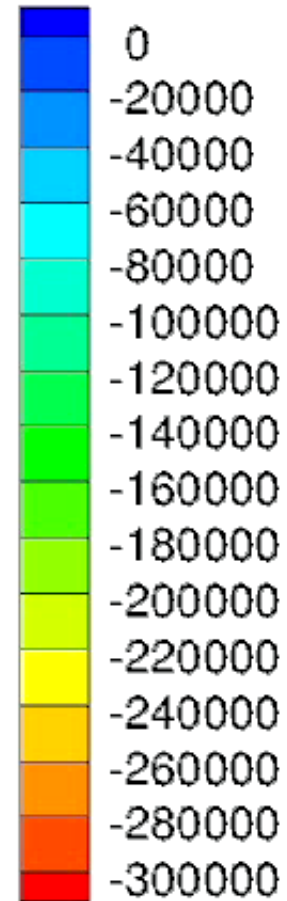
<i>Structure</i>	ρ	$K(\text{Pa})$	B	Γ_0	$\mu(\text{Pa})$
<i>Ventricle</i>	1040	2.19e9	3.063e8	6.15	2.25e4
<i>Glia</i>	1040	2.19e9	3.063e8	6.15	2.253e4
<i>WhiteMatter</i>	1040	2.19e9	3.063e8	6.15	2.253e4
<i>Gray Matter</i>	1040	2.19e9	3.063e8	6.15	2.253e4
<i>Eyes</i>	1040	2.19e9	3.063e8	6.15	2.253e4
<i>VenousSinus</i>	1040	2.19e9	3.063e8	6.15	2.013e4
<i>CSF</i>	1040	2.19e9	3.063e8	6.15	2.253e4
<i>Air Sinus</i>	1040	2.19e9	3.063e8	6.15	2.253e2
<i>Muscle</i>	1100	3.33e6	4.662e5	6.15	3.793e4
<i>Skin/Fat</i>	1040	3.47e7	4.866e6	6.15	5.880e6
<i>Structure</i>	$\rho(\text{kg/m}^3)$	$E(\text{Pa})$	ν	C_0	s
Skull	1412	6.5e9	0.22	1.85e3	0.94



DVBIC - MIT Full Head Model



Pressure [Pa]

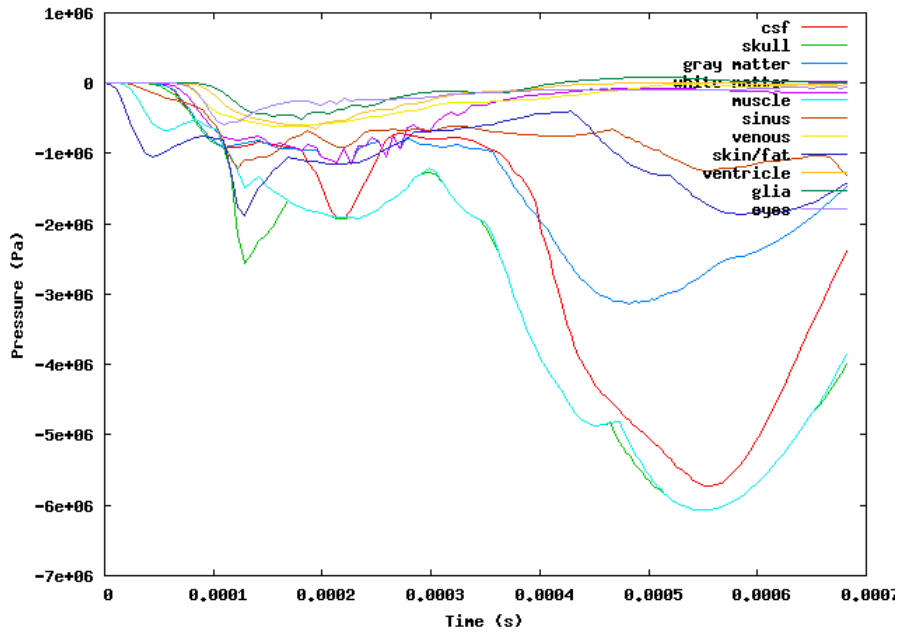


Time: 0.001820 sec

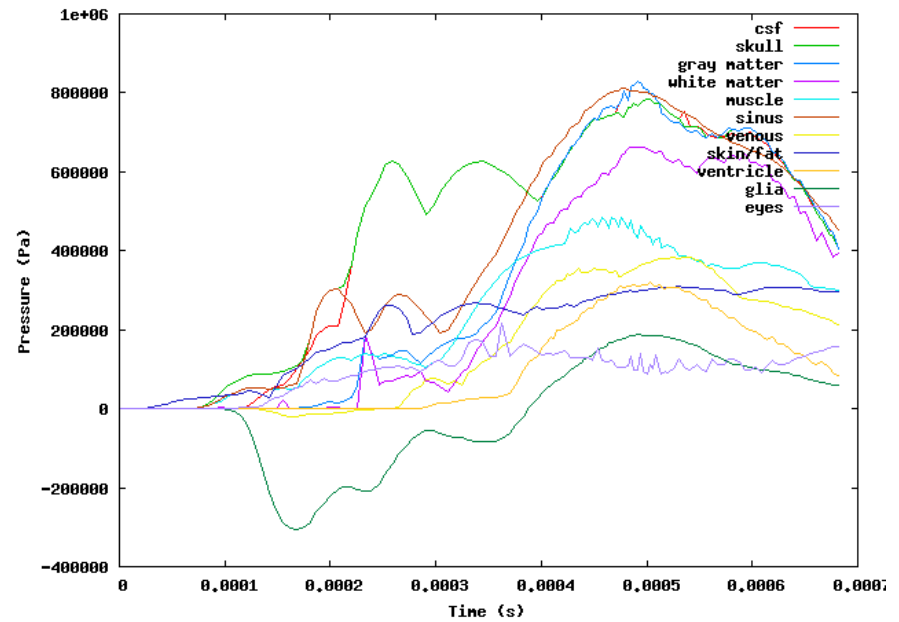


Intracranial pressure by structure (threshold)

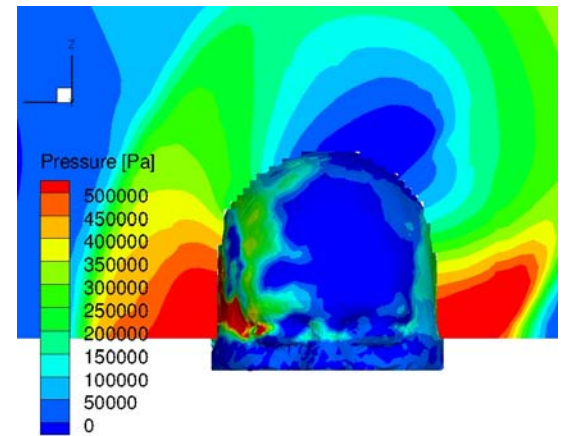
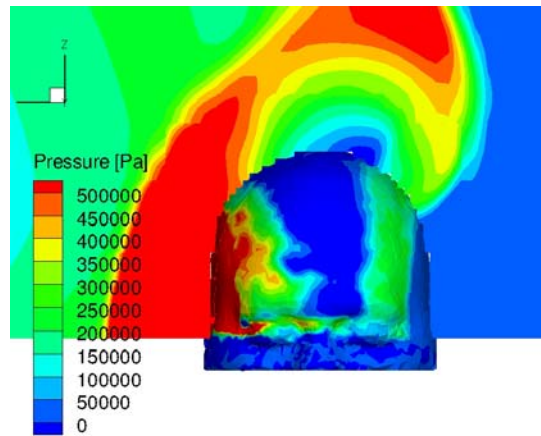
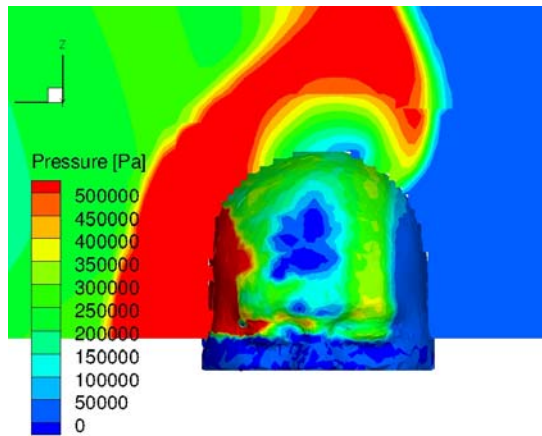
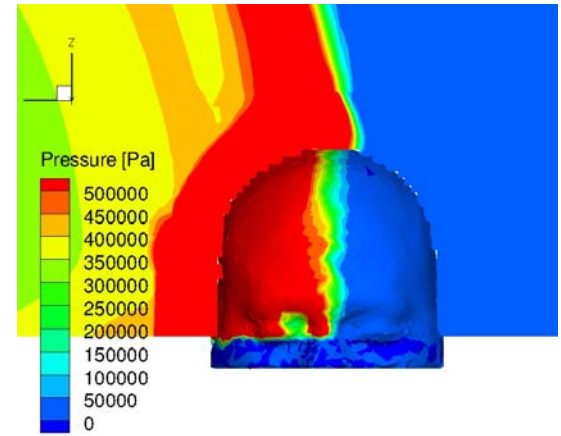
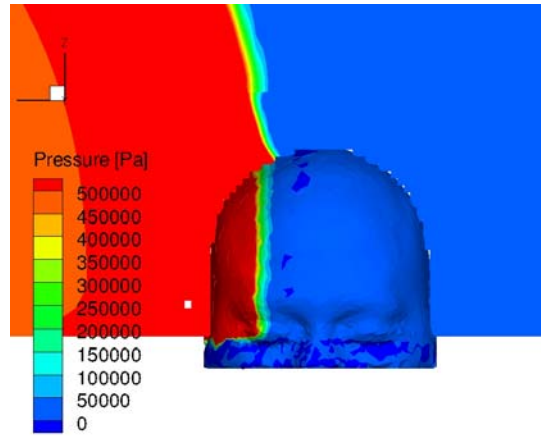
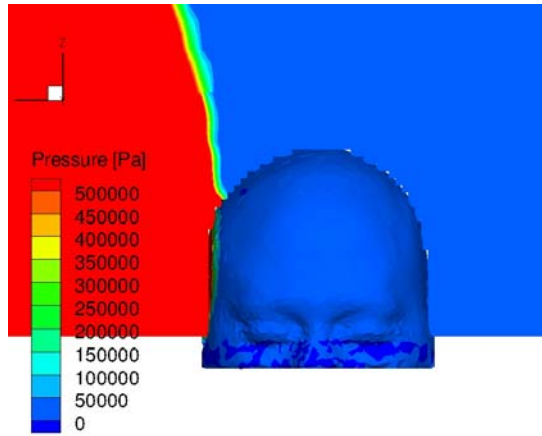
Blast Simulation, 6 atm -- Compression



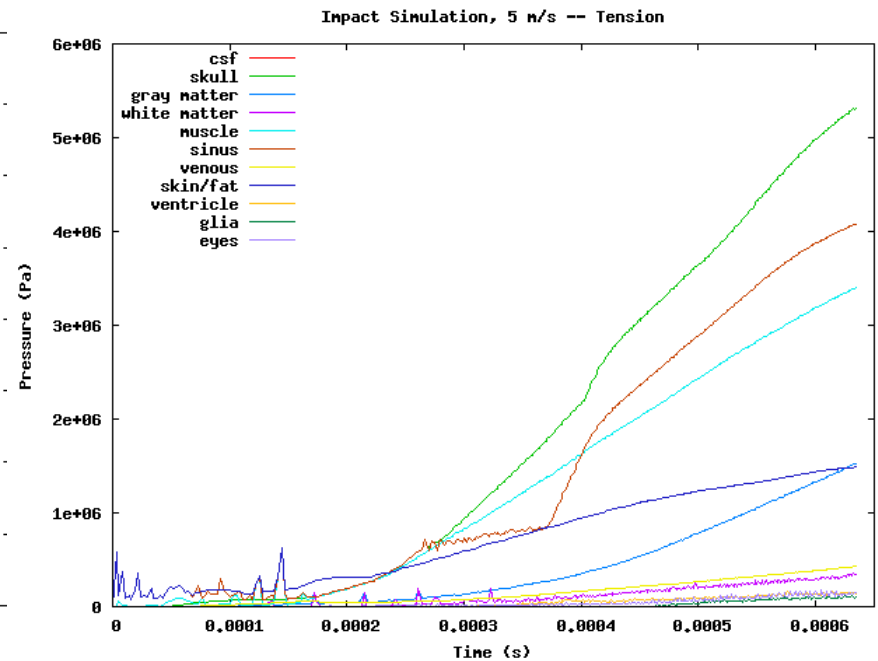
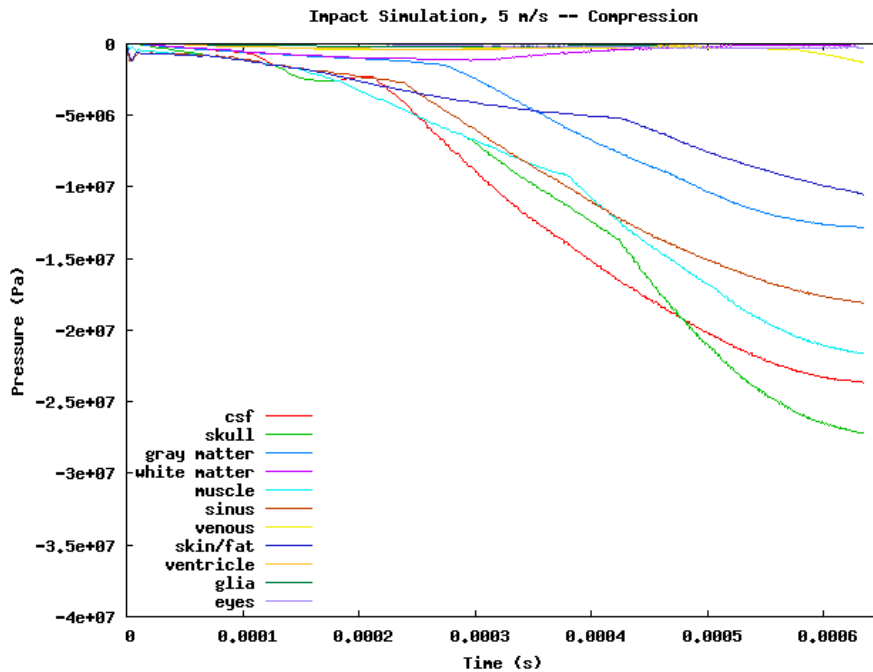
Blast Simulation, 6 atm -- Tension



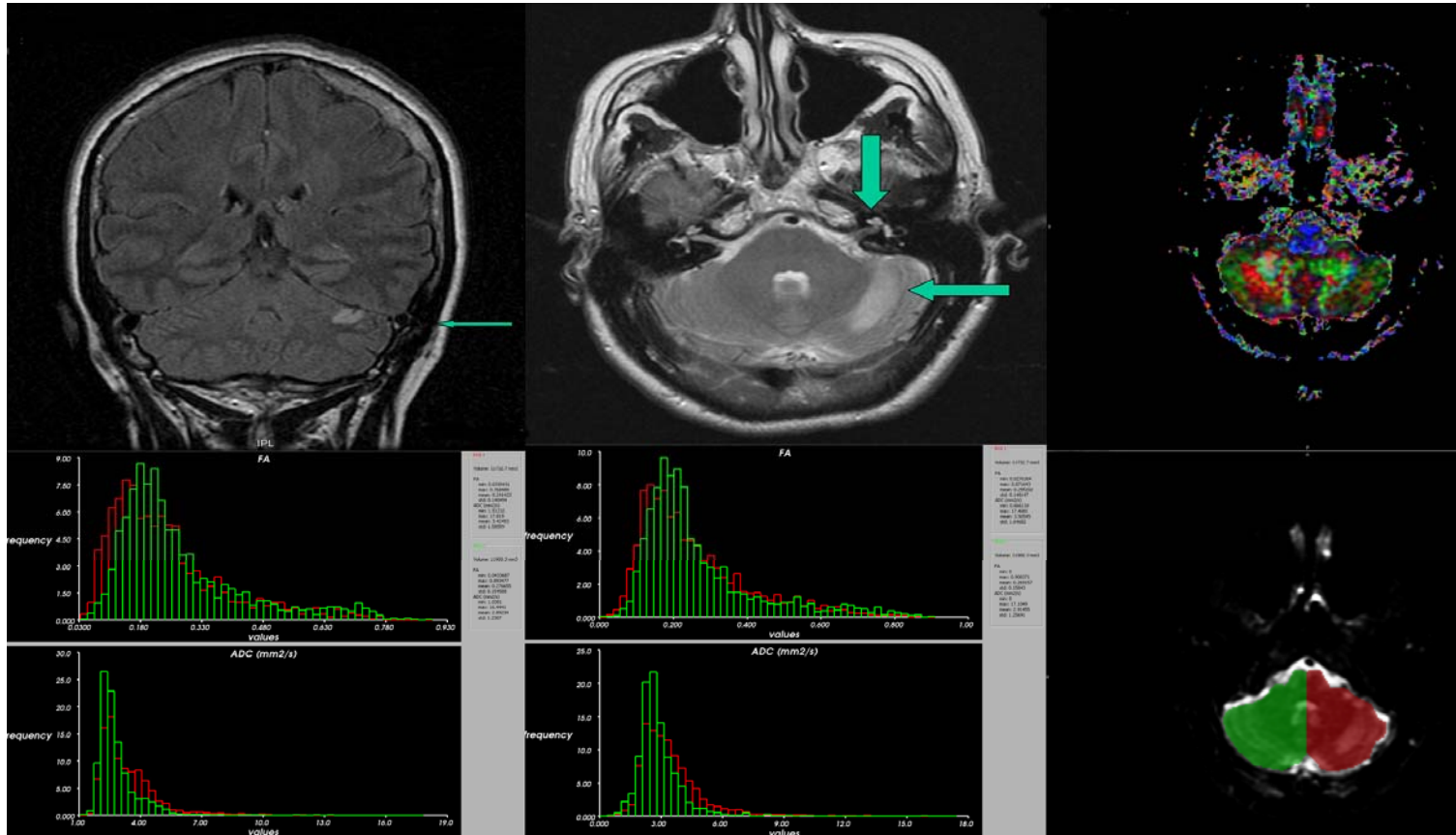
Blast wave pressure field



Intracranial pressure by structure (impact)

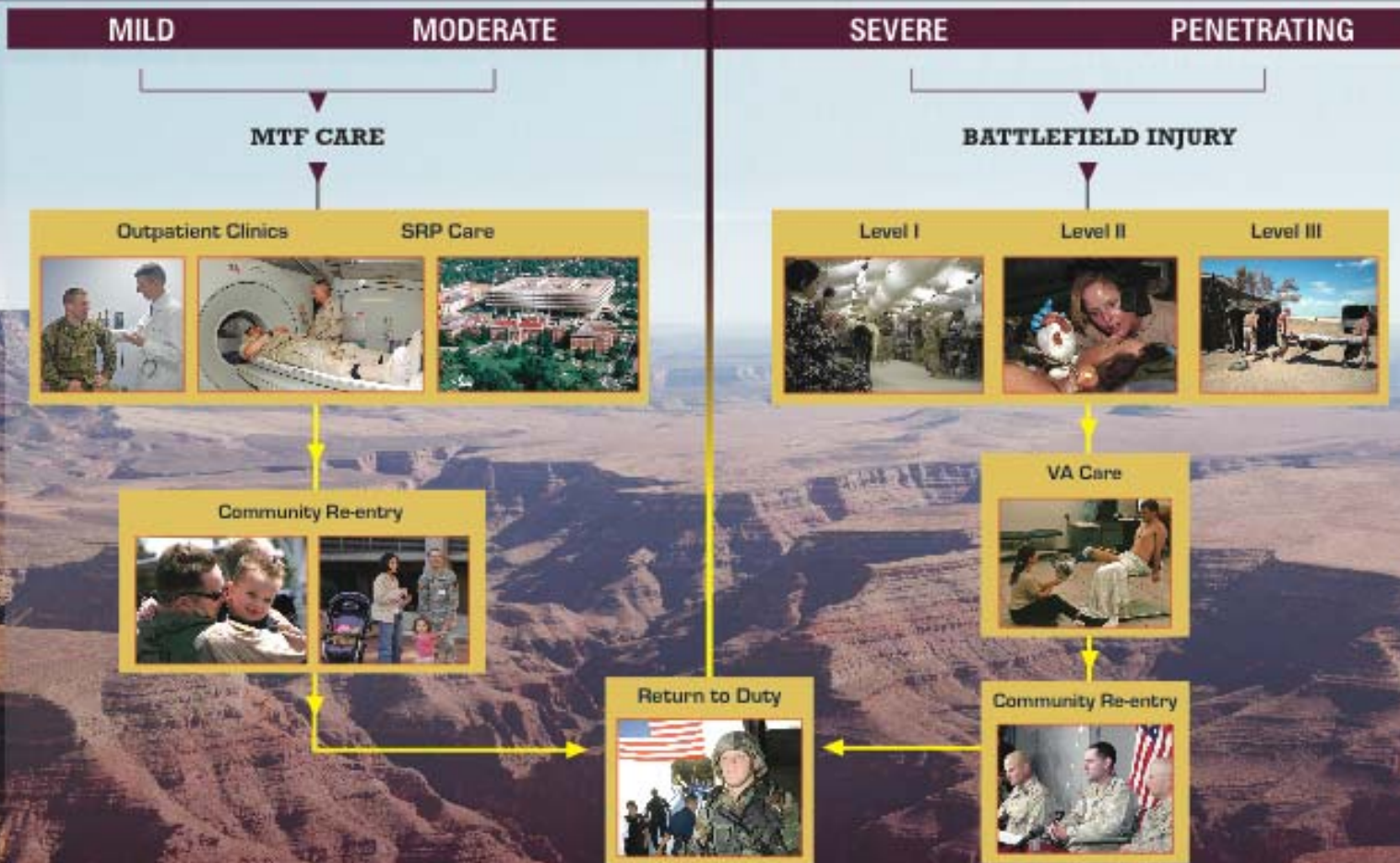


Primary Blast Injury



Traumatic Brain Injury

DEEP AND WIDE



Thank You

