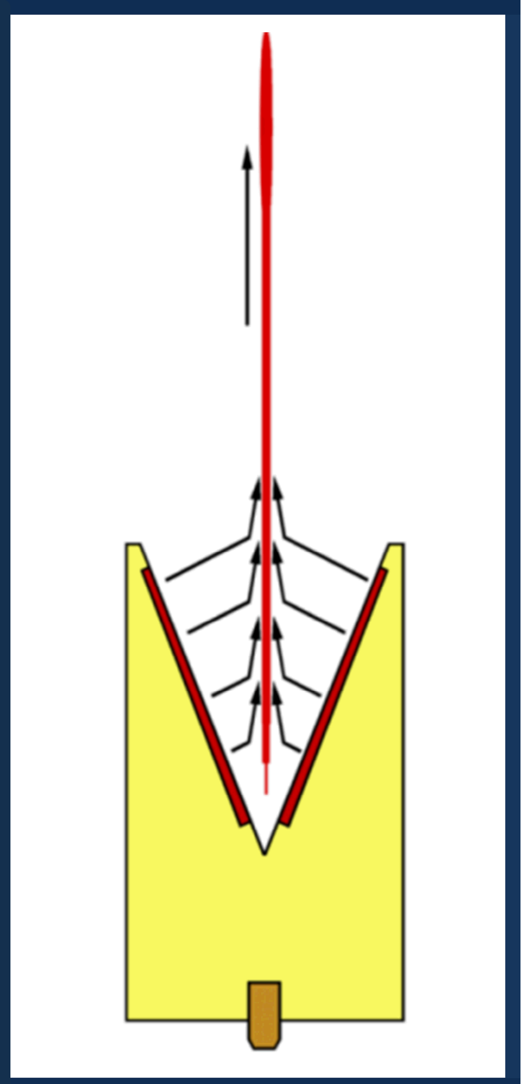
Symposium
July 26th, 2016

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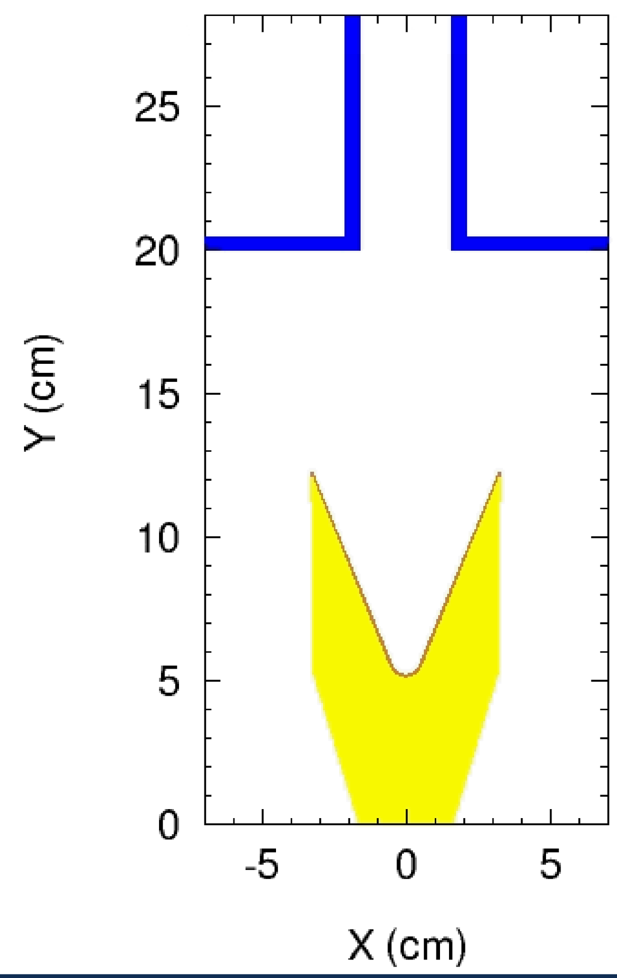
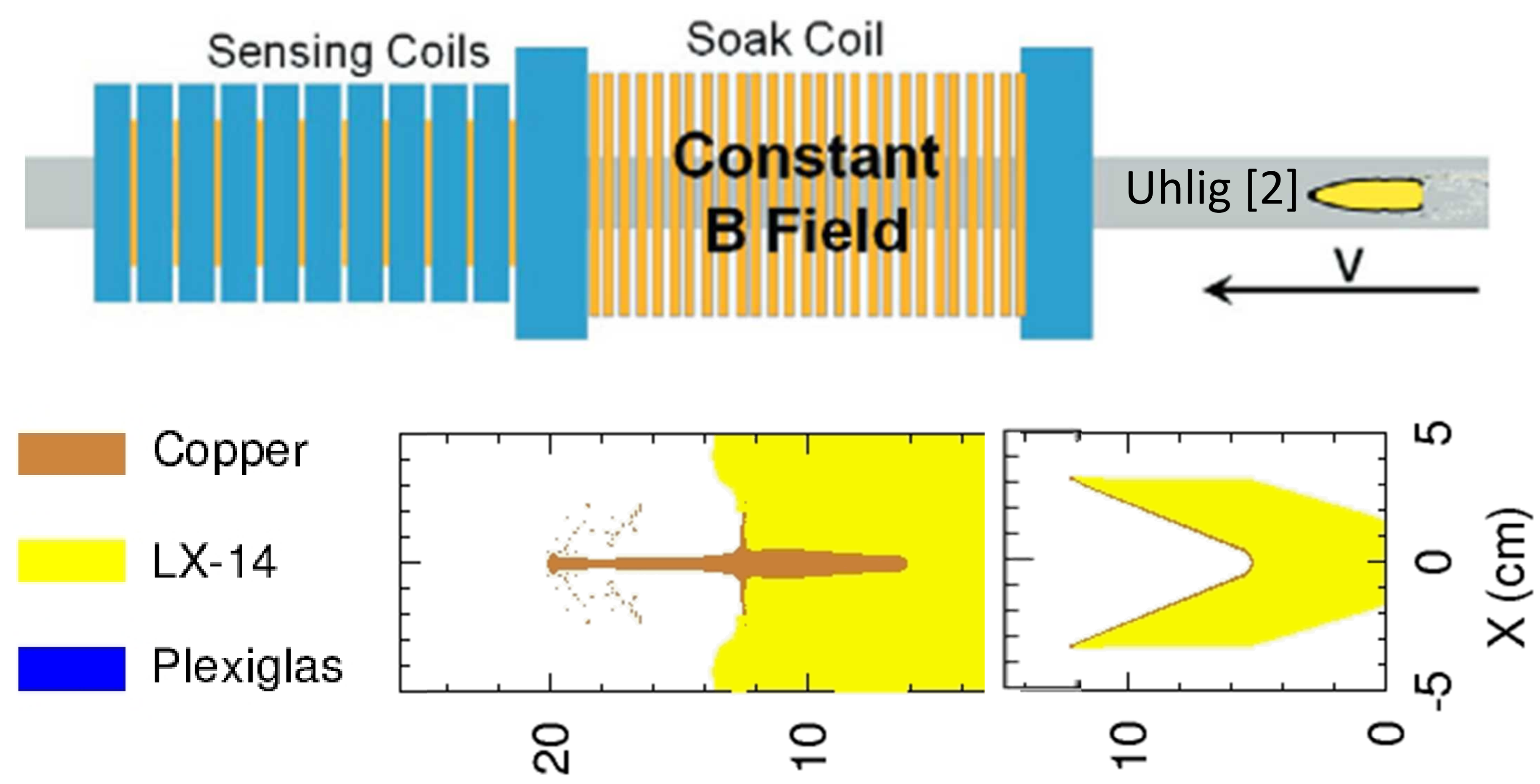
In-Flight Temperature of a Shaped Charge Jet

SAND2016-6777D

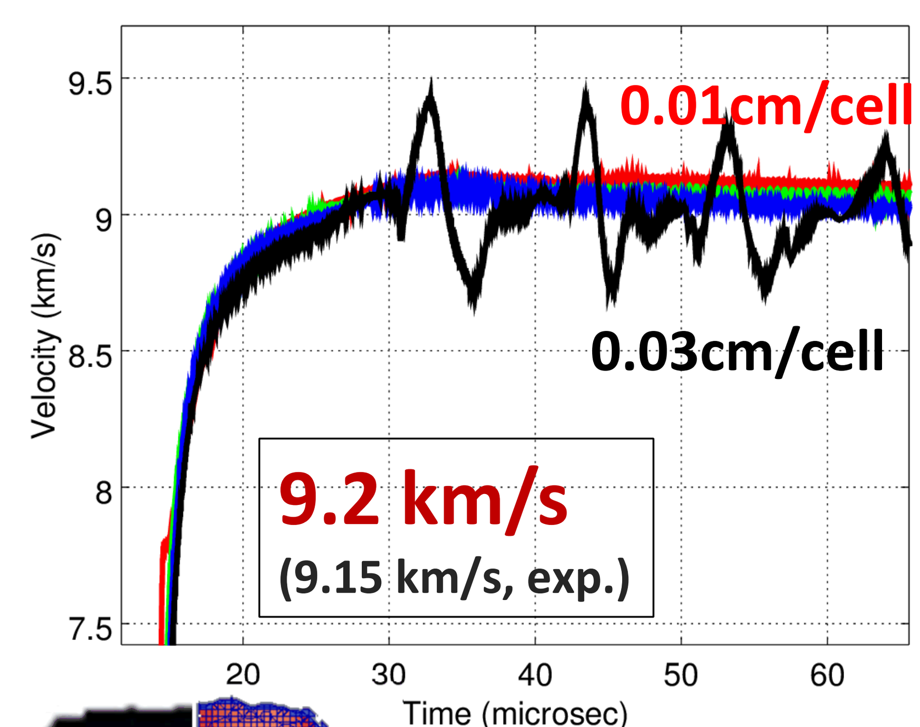
Introduction: With the frequent use of hydrocodes as an assessment tool, computational consistency with experiments are vital. Here, CTH temperature calculations of a shaped charge jet are compared to both experimental data and previous ALEGRA simulations in an effort to establish a benchmark [1,2].

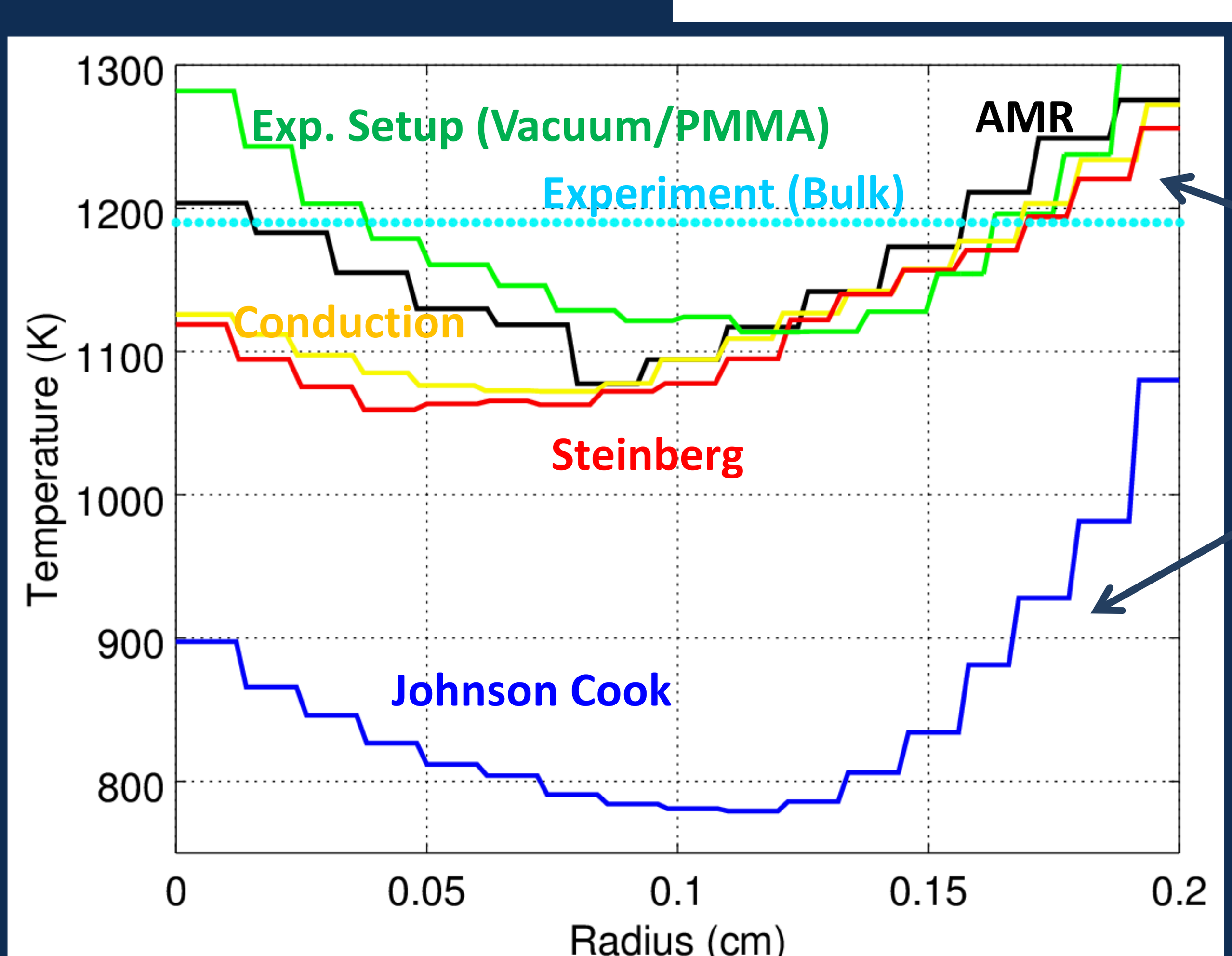


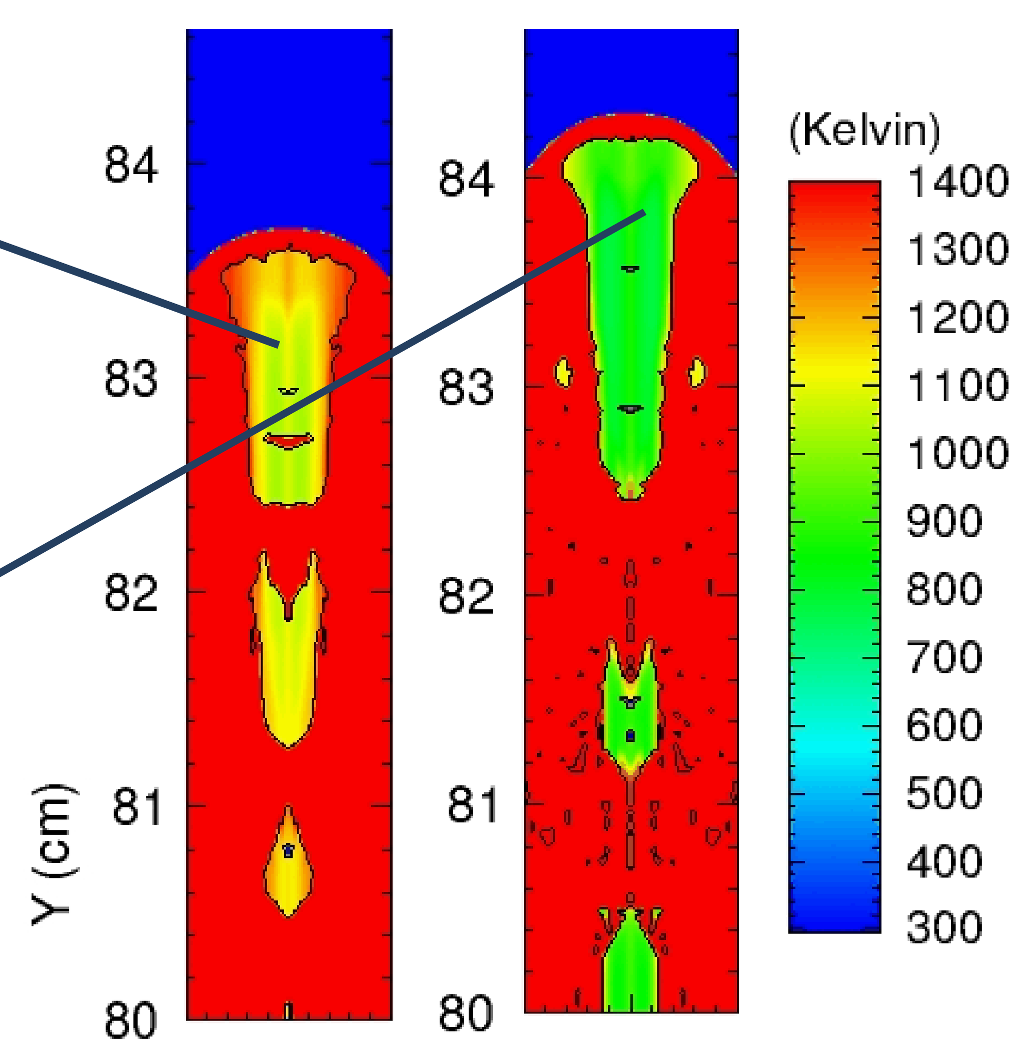


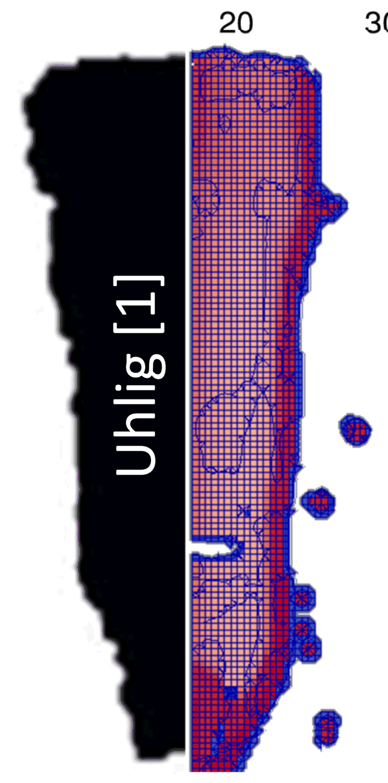
Methods: The ARL was able to induce a magnetic field onto a jet in-situ, the decay of which describes conductivity and therefore temperature [1,3]. This same AC-14 (viper) charge setup was created within CTH and parameters were systemically altered for comparison to data.

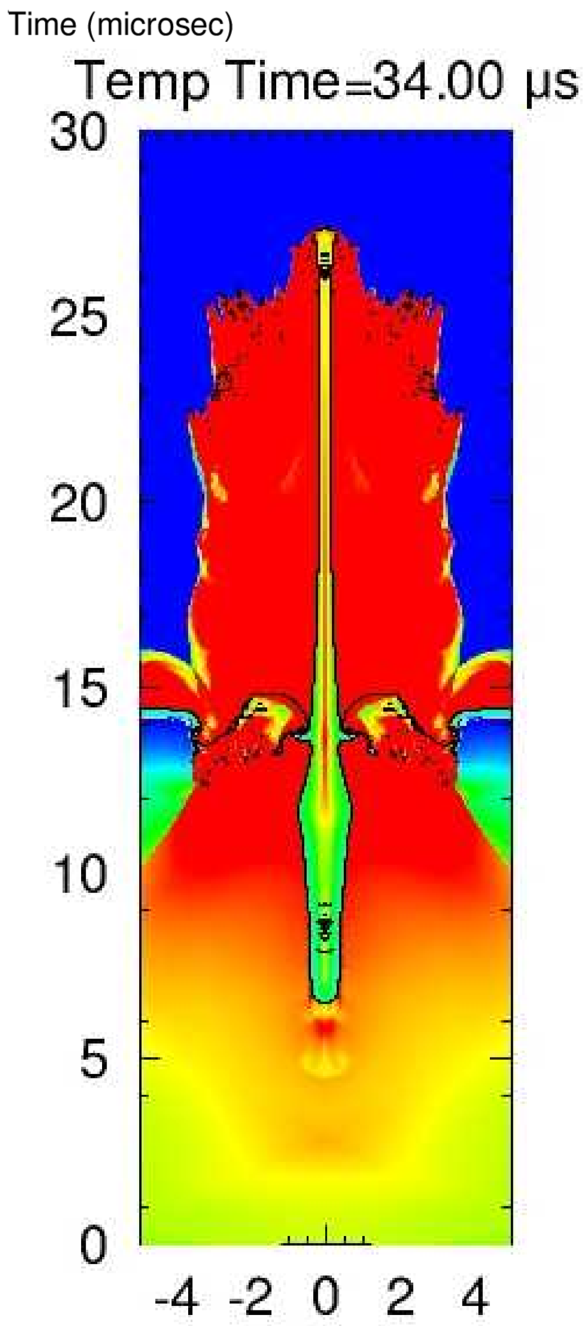
Dimension	Resolution	Insertion	EOS	Strength
2D Cylin.	0.0125 cm/cell	Copper Lining	Sesame	Stein/JO
		LX-14 Explosive	JWL	--
		Air	Sesame	--
		PMMA	Mie Grun	EPPVM











Software	*Strength Model*	*Variation*	*Temp (K)*	*Exp. T(K)*	*±*	*Error*
CTH	Johnson Cook	Air	850	1190	60	0.286
	Steinberg	Air	1160			0.025
		Air/Heat Cond	1147			0.036
		Exp. Setup	1204			0.012
ALEGRA*	Johnson Cook	Air	850			0.286
	Steinberg	Air	1260			0.059

Results: CTH results show that simulations using the Steinberg strength model correlate well with experimental data (within 1.2%). This is further corroborated by experimental error, within which all Steinberg simulations fall. In contrast, implementing Johnson Cook does *not* predict the same measured temperatures suggesting the vital importance of material strength within the jet formation problem – reaffirmed by previous ALEGRA results. Jet structure was, additionally, seen to be accurately predicted.

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[1] Uhlig, Hummer. ARL-TR-5609. July 2011
[2] Niederhaus, Uhlig. SAND2011-2819. July 2011
[3] Uhlig, Hummer. Procedia Eng. 58, 48-57. 2013
[4] Monniaux, David. *High Explosive Anti Tank Round*. 2005. Esplanade Des Invalides, Paris, France.
[5] Antitank Cumulative Ammunition. Basyny.net/t/en/

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NNSA National Nuclear Security Administration

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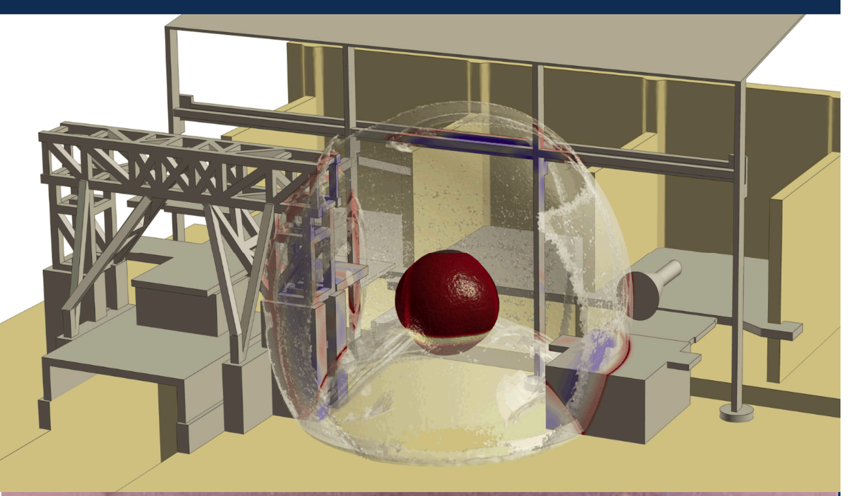

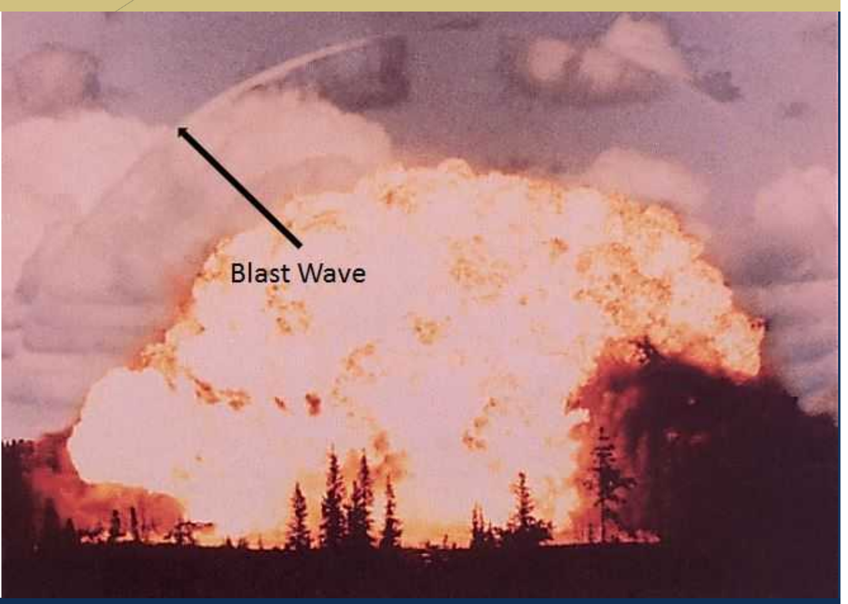

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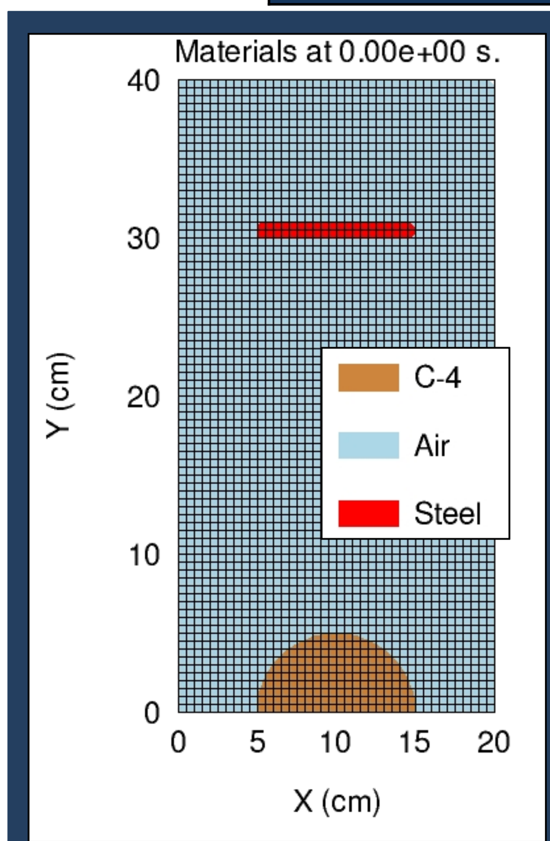
Blast-Structure Interactions in CTH, Sierra, and Zapotec

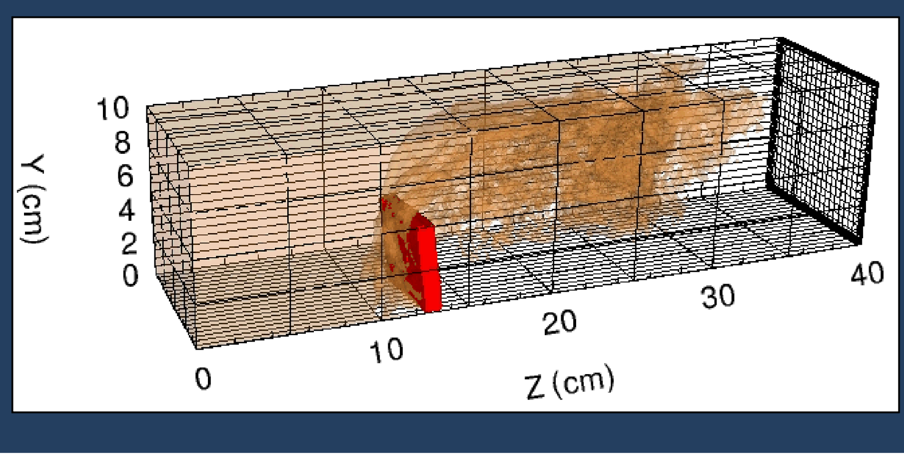
Introduction: Blast-structure interactions represent a unique problem set where the accuracy of both hydrodynamic and structural system responses are critical. Traditionally, analysis of these are conducted from the perspective of either Eulerian hydrocodes *or* Lagrangian finite element approaches. Here a comparative analysis of a plate under blast loading is done using both (CTH/Sierra) which is then further compared to Zapotec, a software which links the two.

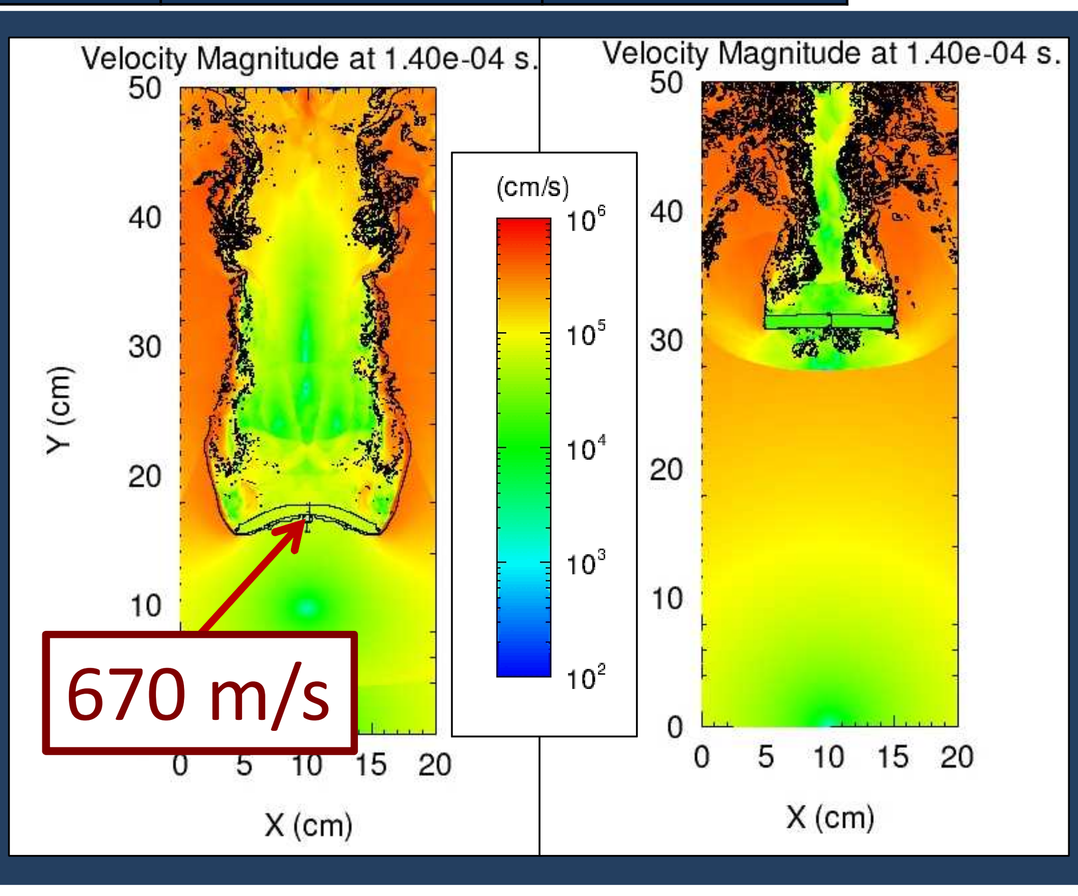
CTH Setup	Analysis	Resolution	Standoff	EOS	Strength
	2D/3DR	≤ 0.02cm/cell	10-40cm	JWL (C4), Ses (Air) Mgr (Steel)	EPPVM



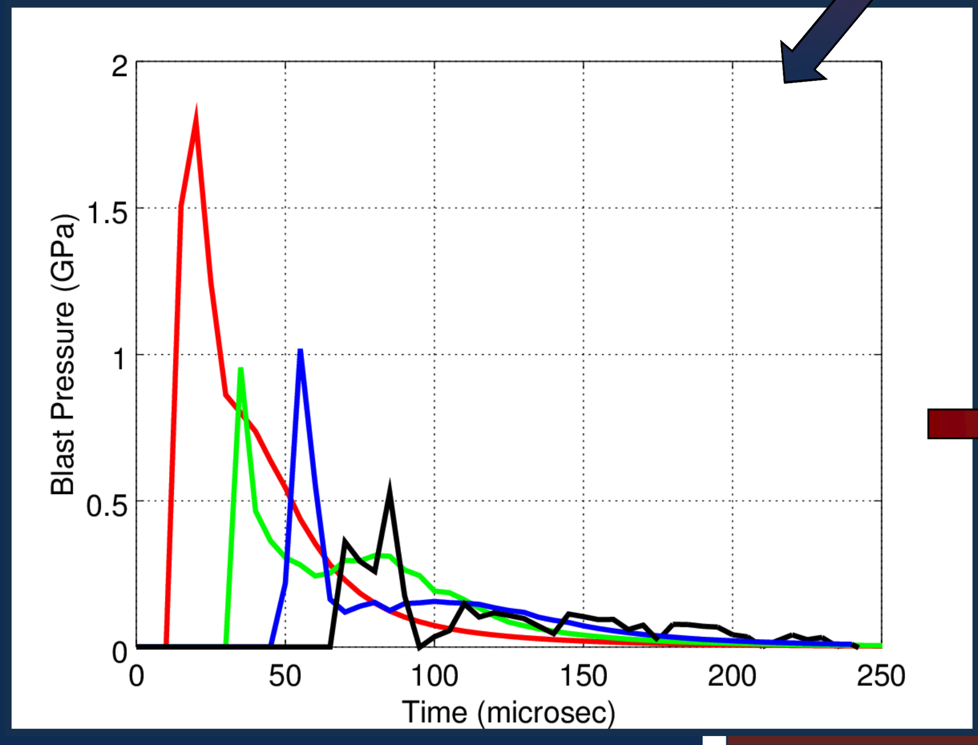
CTH (Eulerian)

- Static mesh
- Built *for* shock and large deformation
- Limited in geometry tracking

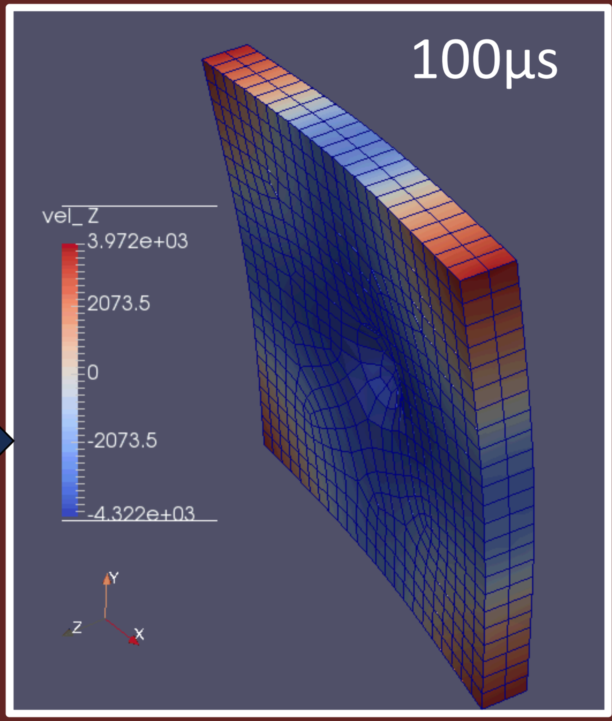




Sierra Setup	Analysis	Resolution	Standoff	Strength
	3DR	≤ 0.5cm/cell	10-40cm	Elastic Plastic

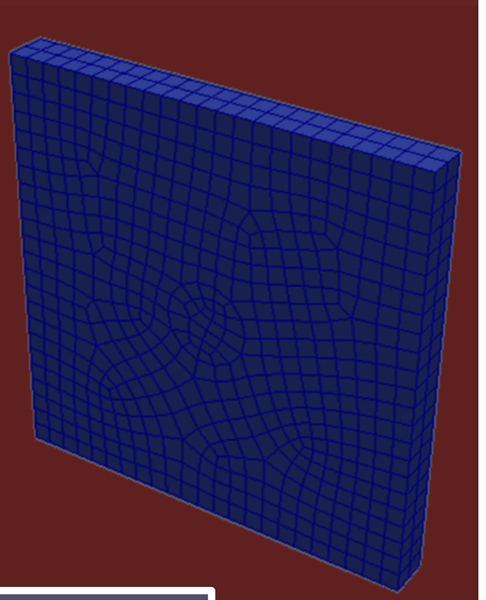


Time Varying Boundary Condition



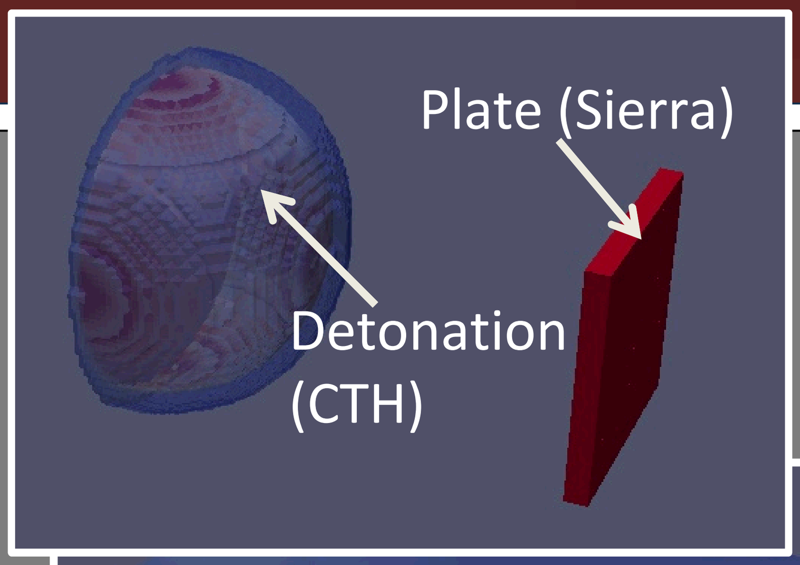
Sierra/Presto (Lagrangian)

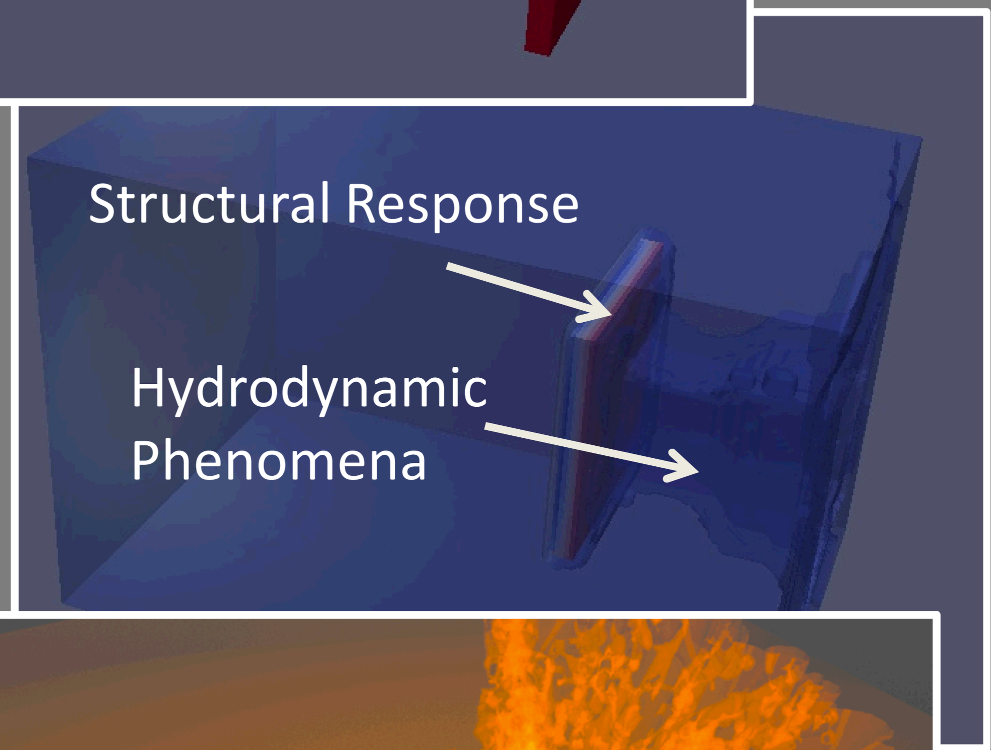
- Deforming mesh
- Built *for* structural response, though limited in large deformation
- Tracks geometry and fracture well

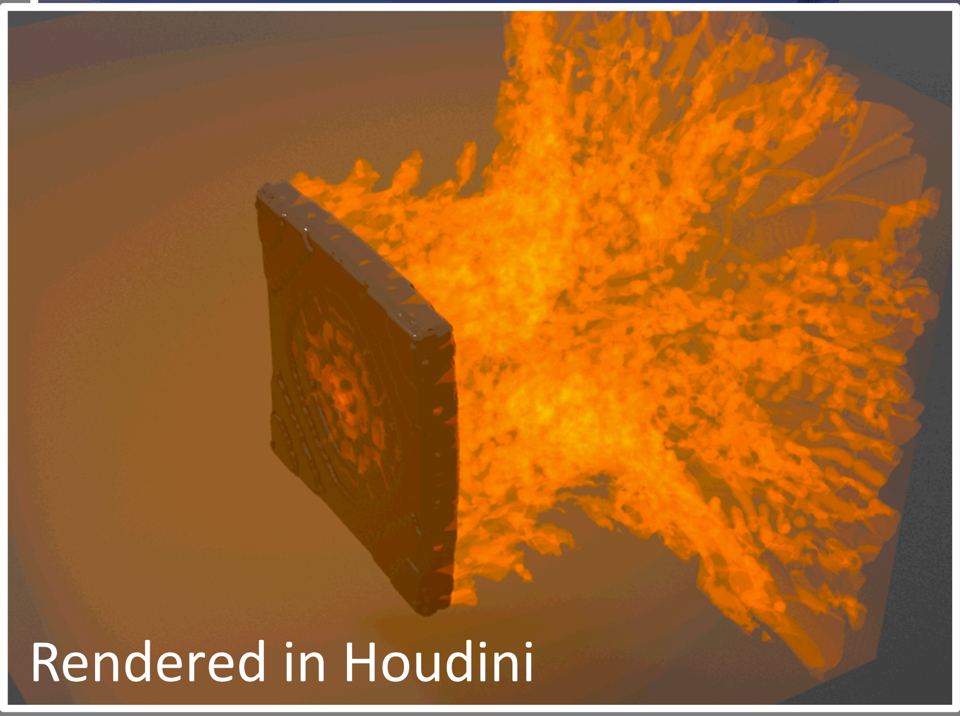


Zapotec (Coupled)

- Lagrangian meshed materials within an Eulerian mesh domain.
- Boundary conditions and local state properties are shared to maintain conservation laws.
- Hydrodynamic and structural response may both be resolved.







Conclusions: The coupling of an Eulerian hydrocode with a Lagrange finite element method allows for more in-depth understanding of structural response under blast loading. Previously in Sierra, modeling a blast wave required approximating the pressure signature as the boundary condition. Linking with CTH eliminates this requirement allowing detonations and shock to still be accurately resolved – providing a more complete analysis of the problem set.

[1] Williams. Blast Wave. NASA. www.nas.nasa.gov/SC13/gallery.html
[2] Richmond. Exposion-Blast Wave. Wikimedia.org/wiki/

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