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Detonator

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# James Space Performance Characterization of an Interaction Detonator

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# Abstract

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Interaction detonators make use of shock wave interactions within an explosive to achieve initiation. Thereby achieving in a group an effect that will not be achieved individually. In this work, the interactions are analyzed in terms of the James initiation criterion to help understand the initiation mechanism.

# James Initiation Criterion and James Space

The James Criterion is

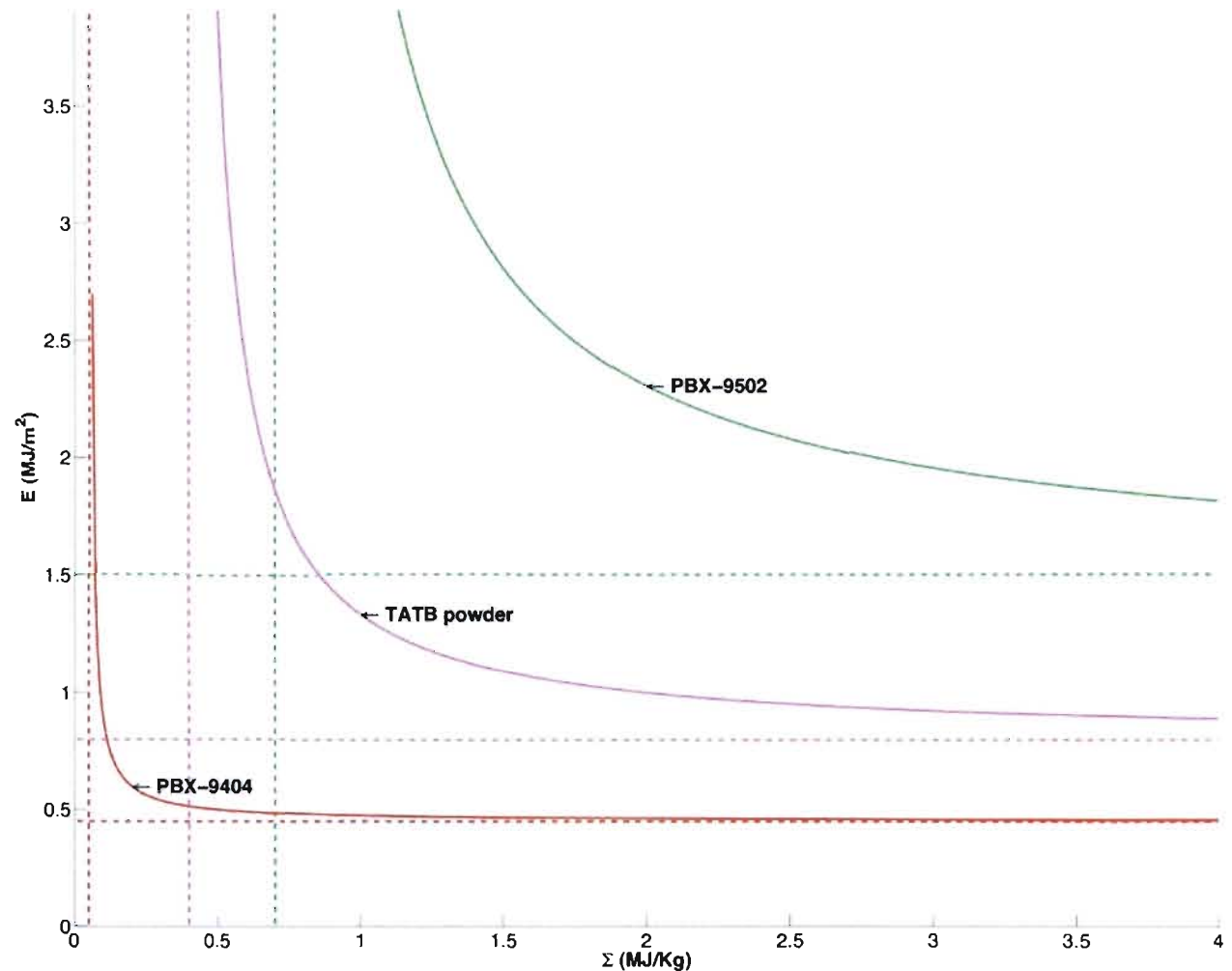
$$1 = \frac{E_C}{E} + \frac{\Sigma_C}{\Sigma}$$

Where,

$$E_C = \int P u_p d\tau,$$

$$\Sigma_C = \frac{u_p^2}{2}$$

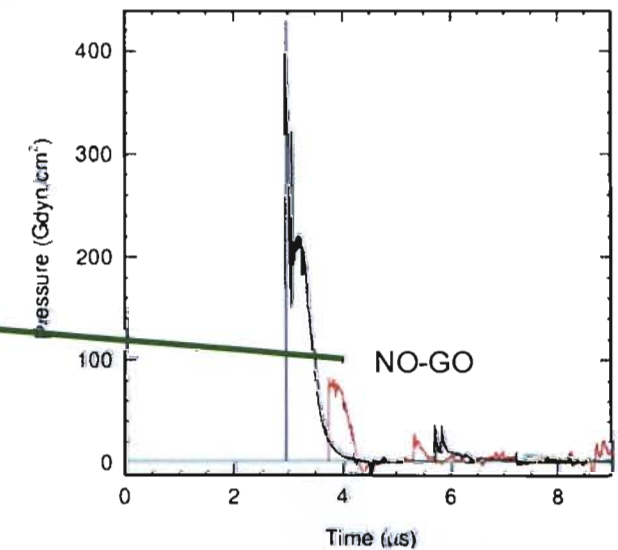
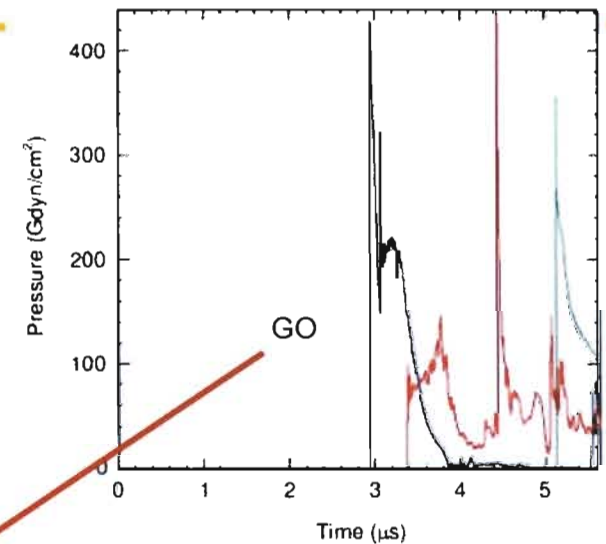
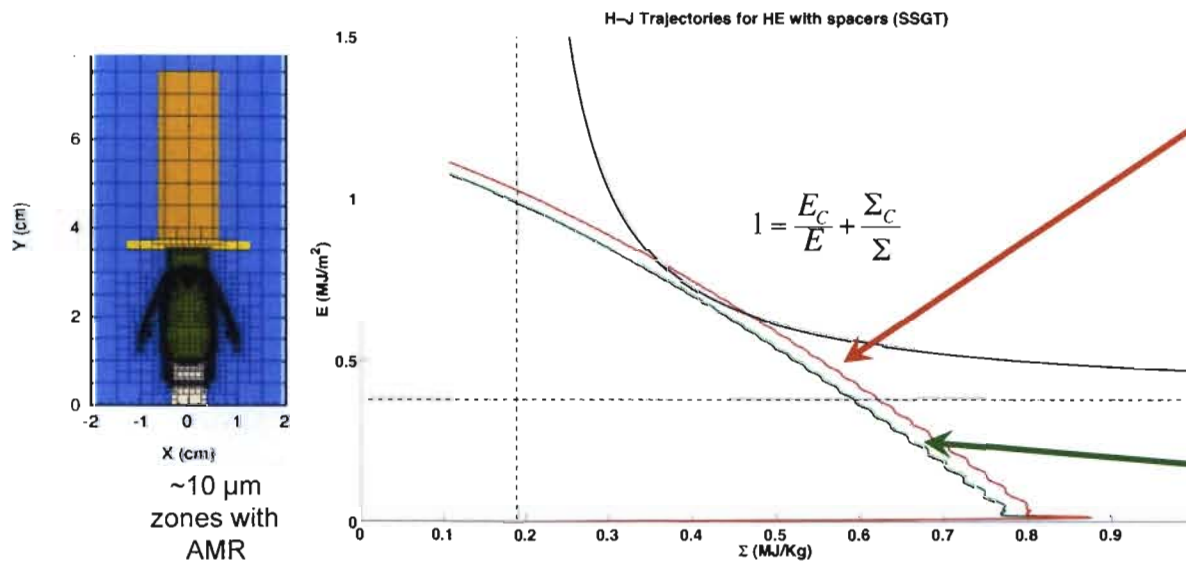
James, H. R., *PEP* 1996



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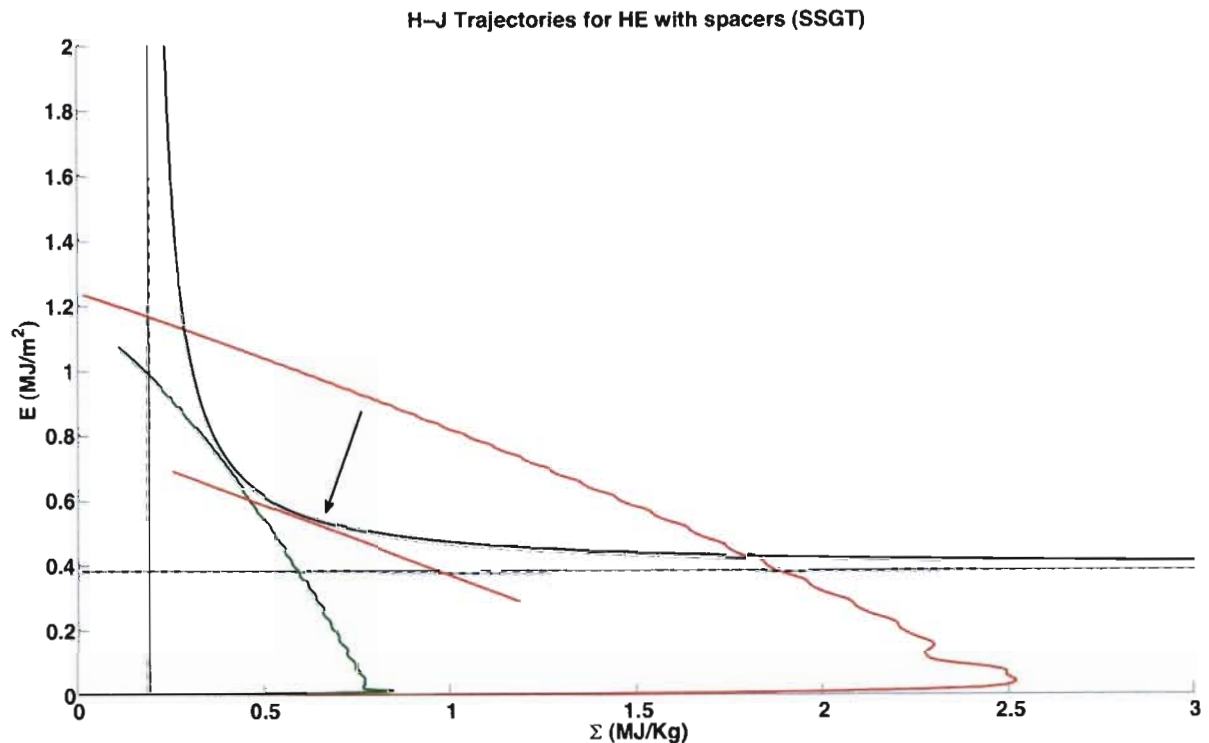
# Detonation Transfer

- Experiments and calculations to study conditions that promote or inhibit initiation
  - Consists of donor HE, inert layer, acceptor HE
  - Wave-centric view is detonation to shock to detonation
- What gaps or layers will interrupt/transmit a detonation?
- PDV and Schlieren will be used to characterize the drive and establish basis for calculation input

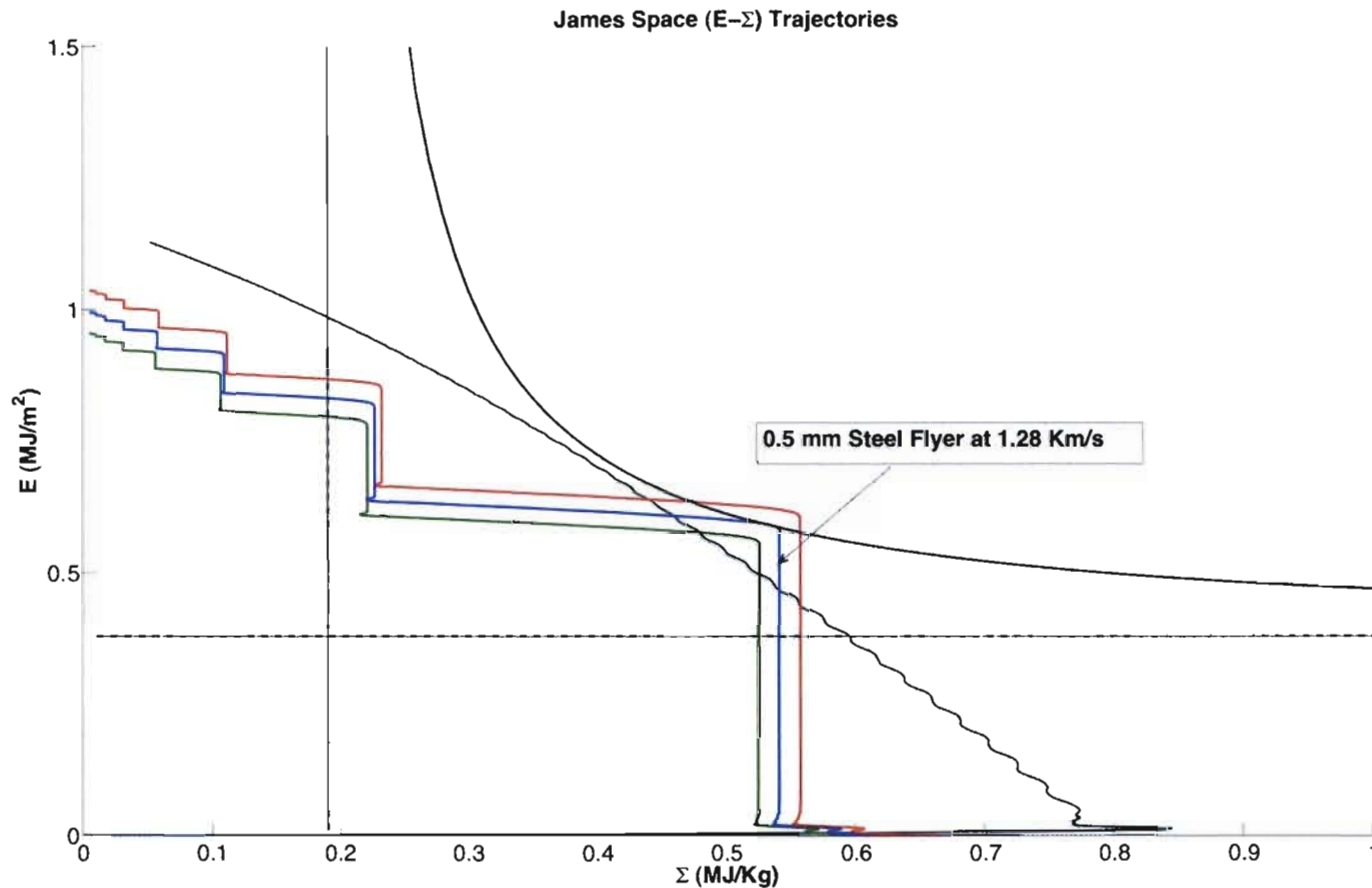


## Variations of LANL SSGT for $E_c - \Sigma_c$ Determination

- The standard brass SSGT finds one intersect of the hyperbola
- Using varied (or omitted) attenuators and/or varied HE drive pellets
  - Many intersects could be obtained
  - Therefore the  $E_c - \Sigma_c$  parameters could be determined
- Useful addition to other data sources

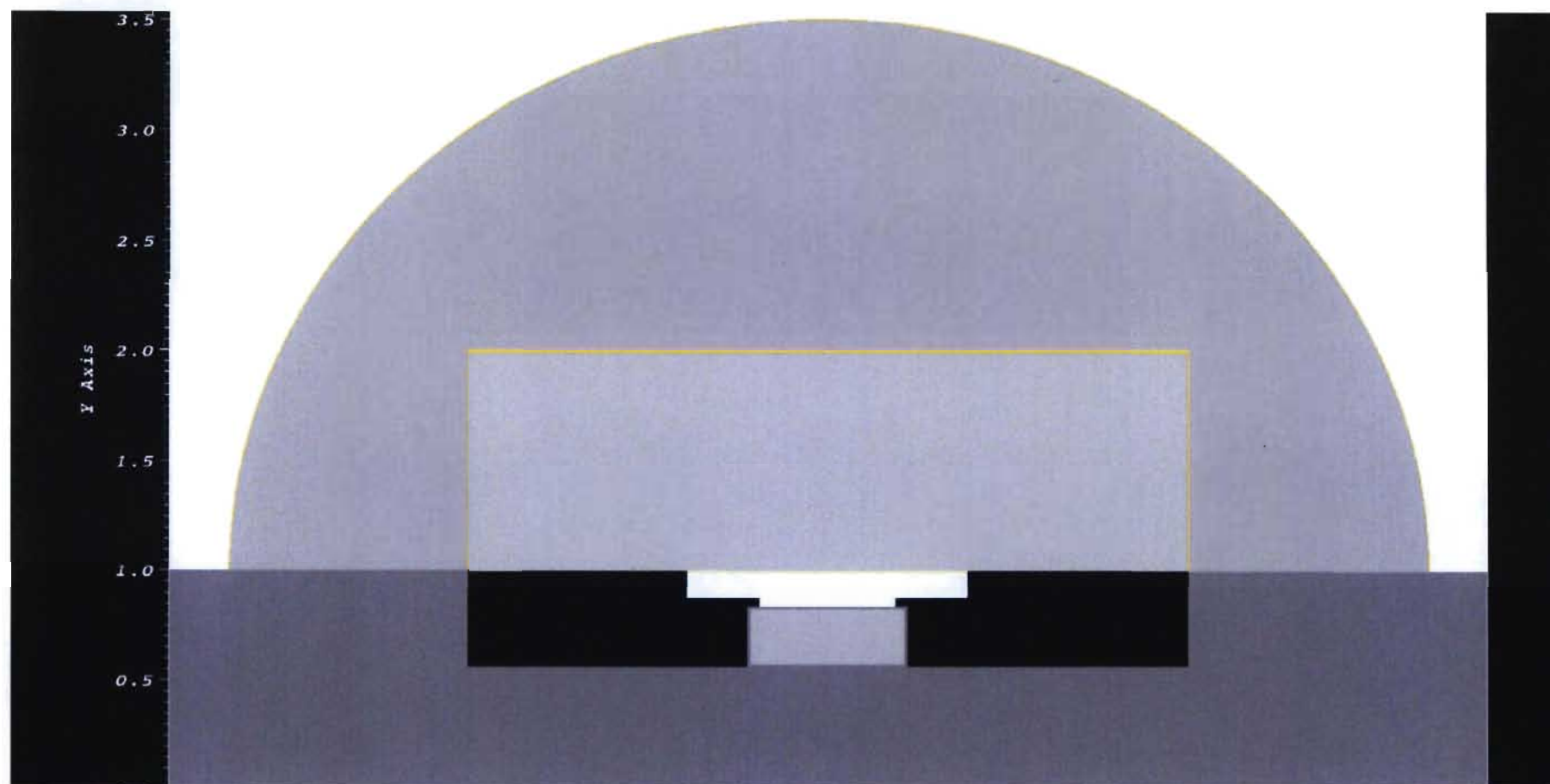


# Flyer Impact Trajectory through James Space





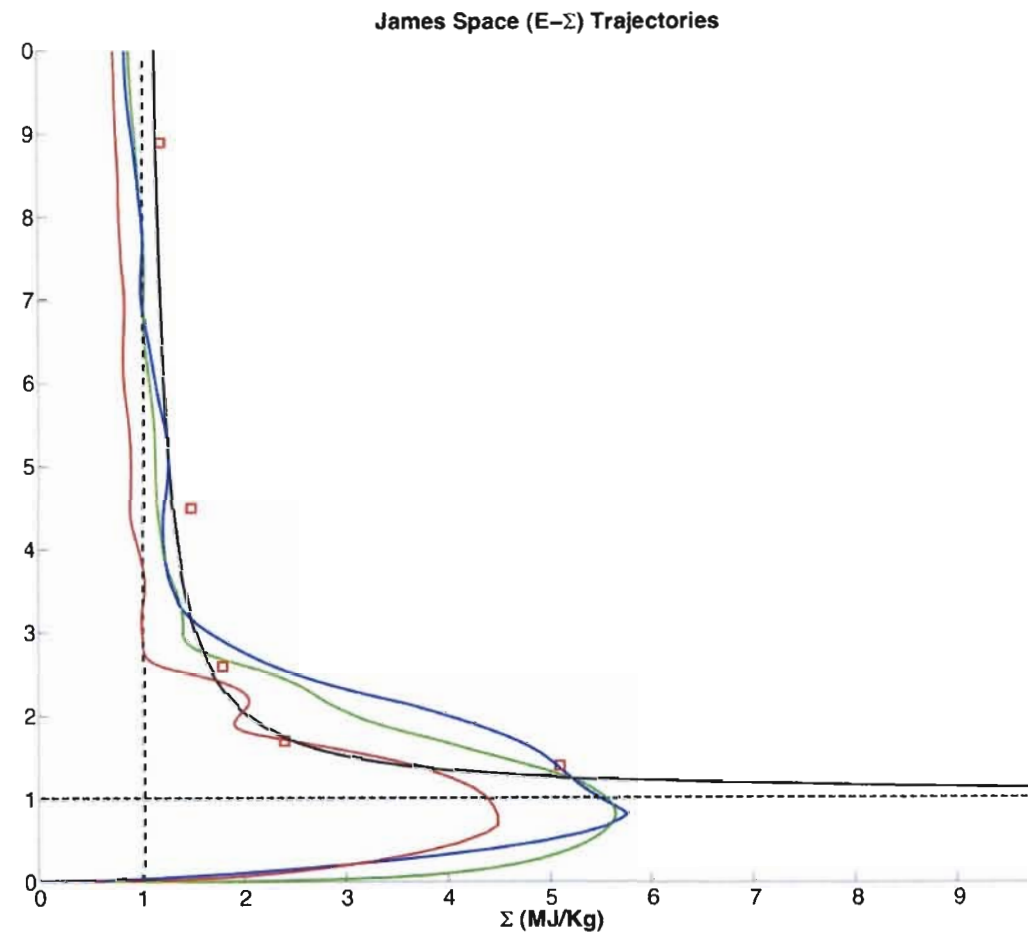
## Previously Studied Onionskins in H-J Space





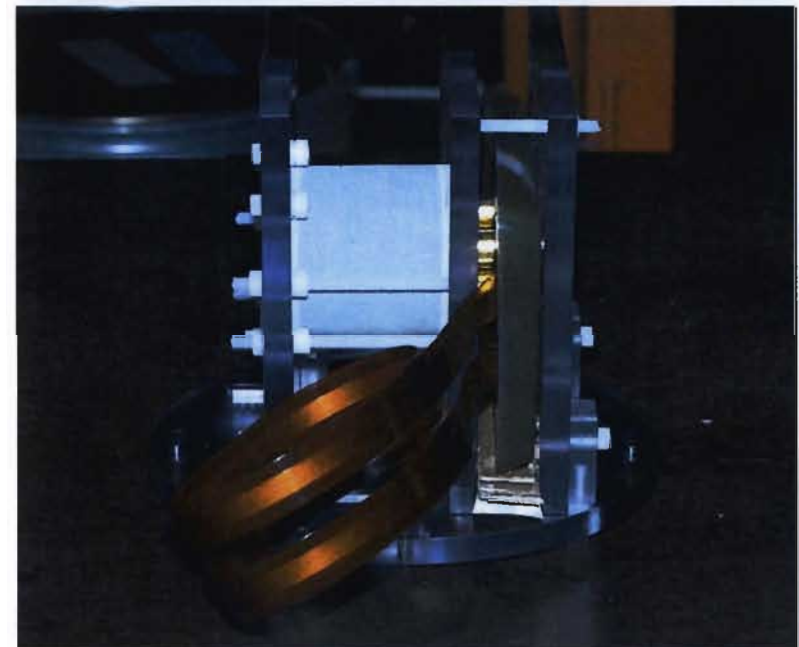
## Back to James Space

- Onionskin calculation in ALE3D with Lagrangian tracer points
  - Top, Side, and corner of booster
  - $P$  and  $u_p$  used to plot trajectory in James space as before
- All three trajectories pass the James criterion
- Data on LX-17 shown for comparison

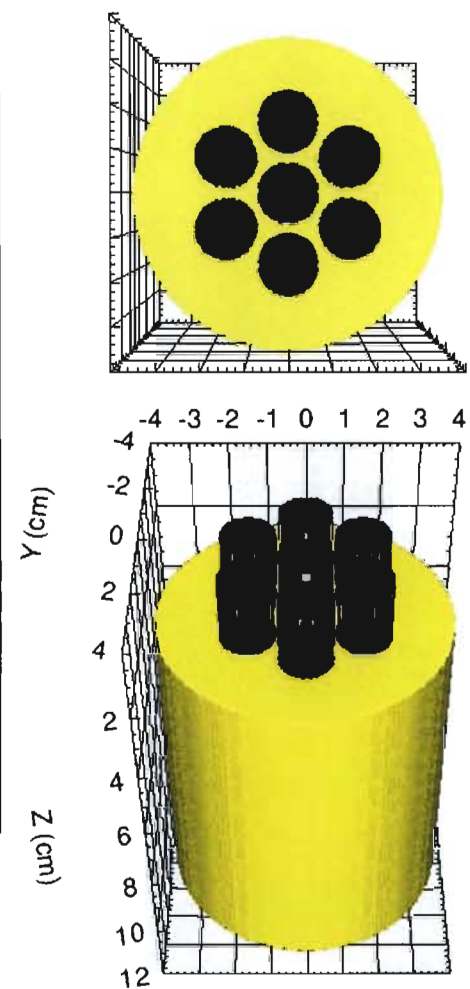
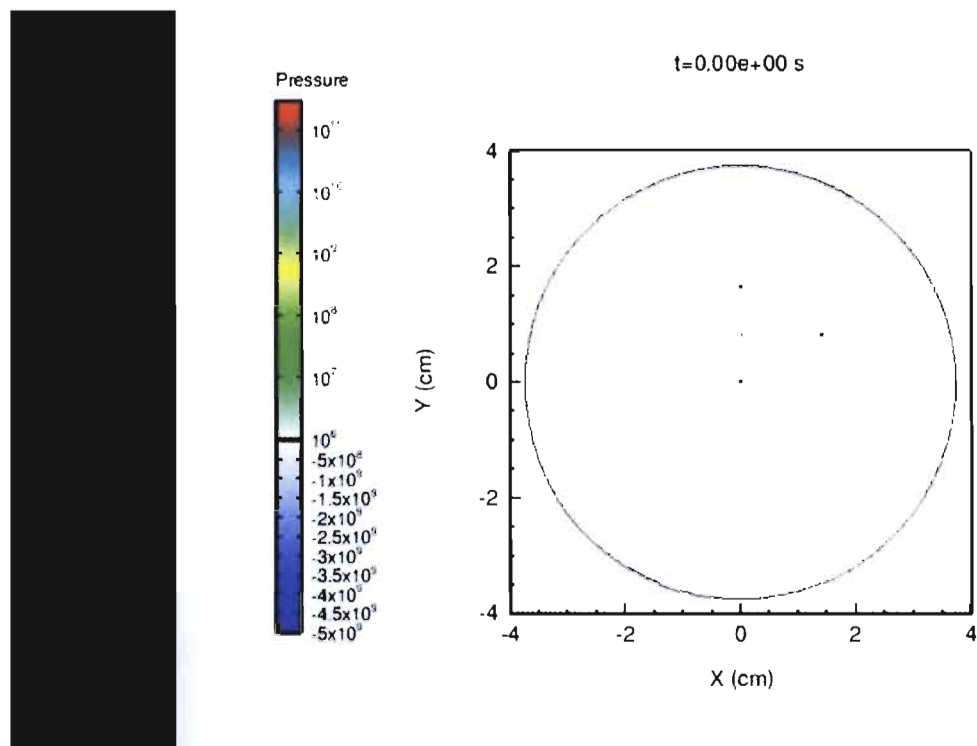


## 7 Point Interaction Detonator

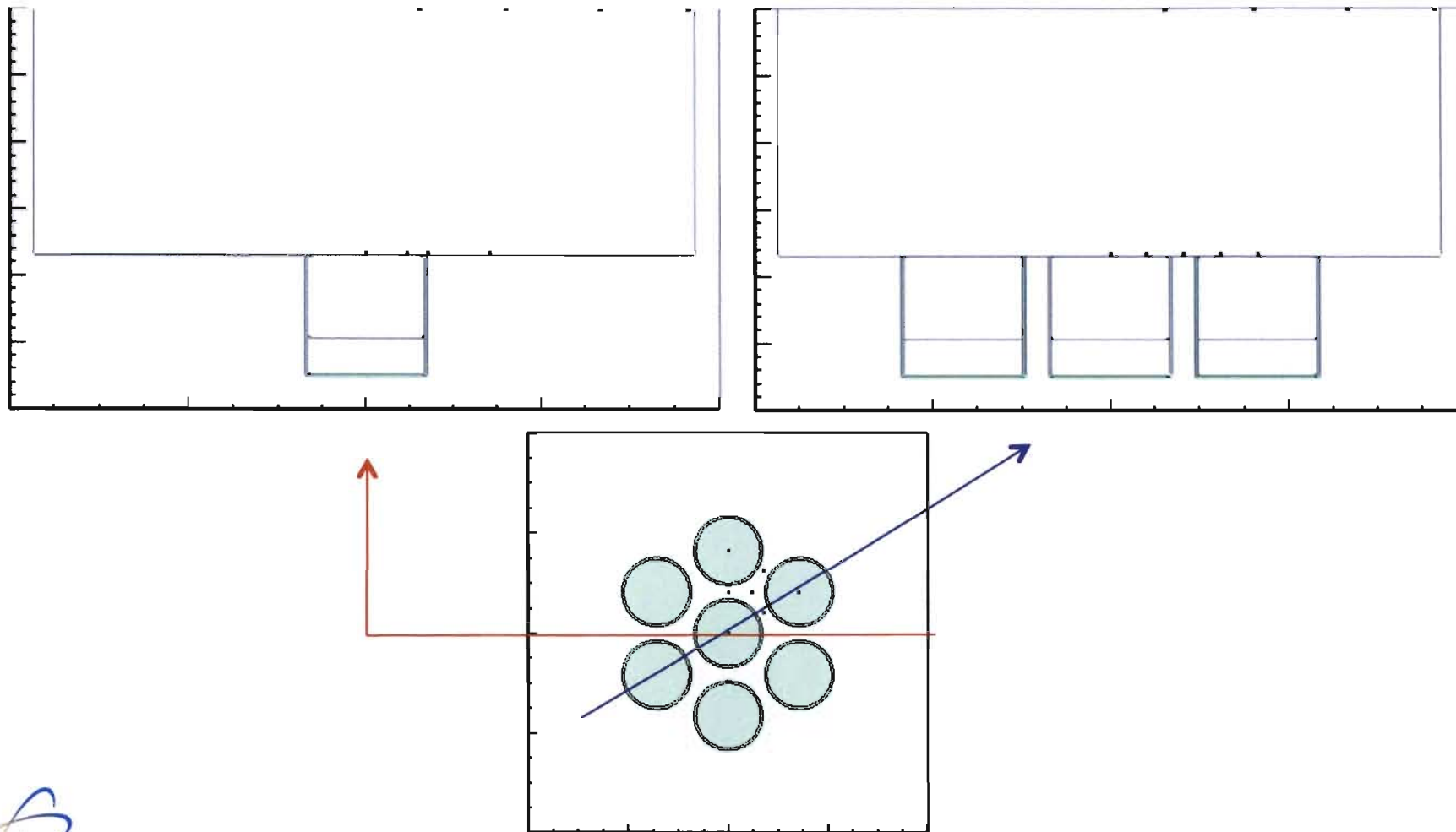
- What about multiple detonator systems?
- Advantage to MDS's is that no single detonator can trigger IHE directly
- It is the shock interaction of multiple detonators *within* the IHE that leads to initiation
- With hydro code calculations we can
  - Simulate misfires
  - Optimize detonator array
  - Study effect of misalignment
  - Get a feel for what the heck is going on in there
  - Interpret this effect in terms of James space



## 7 Point Interaction Detonator

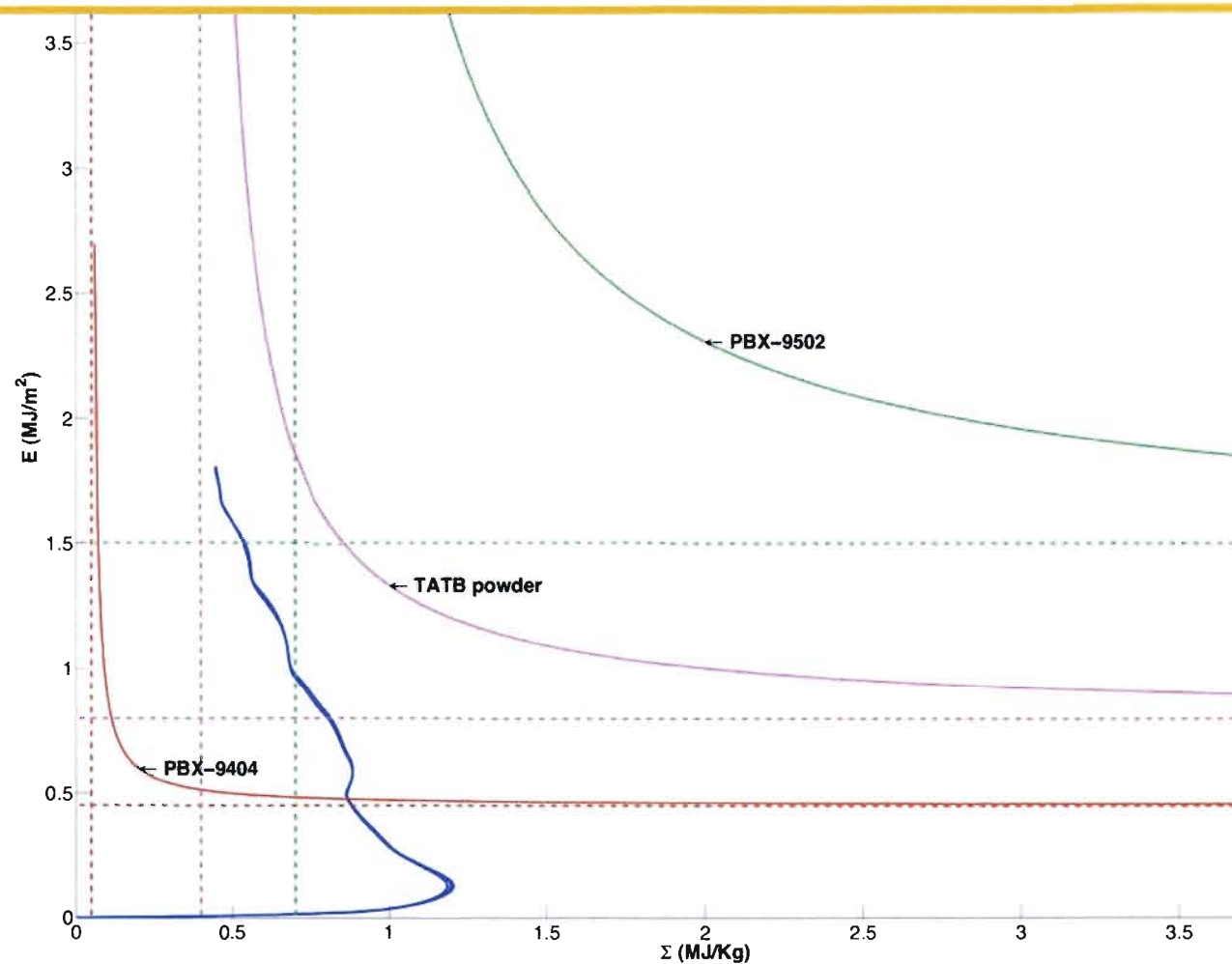


## 7 Point Interaction Detonator

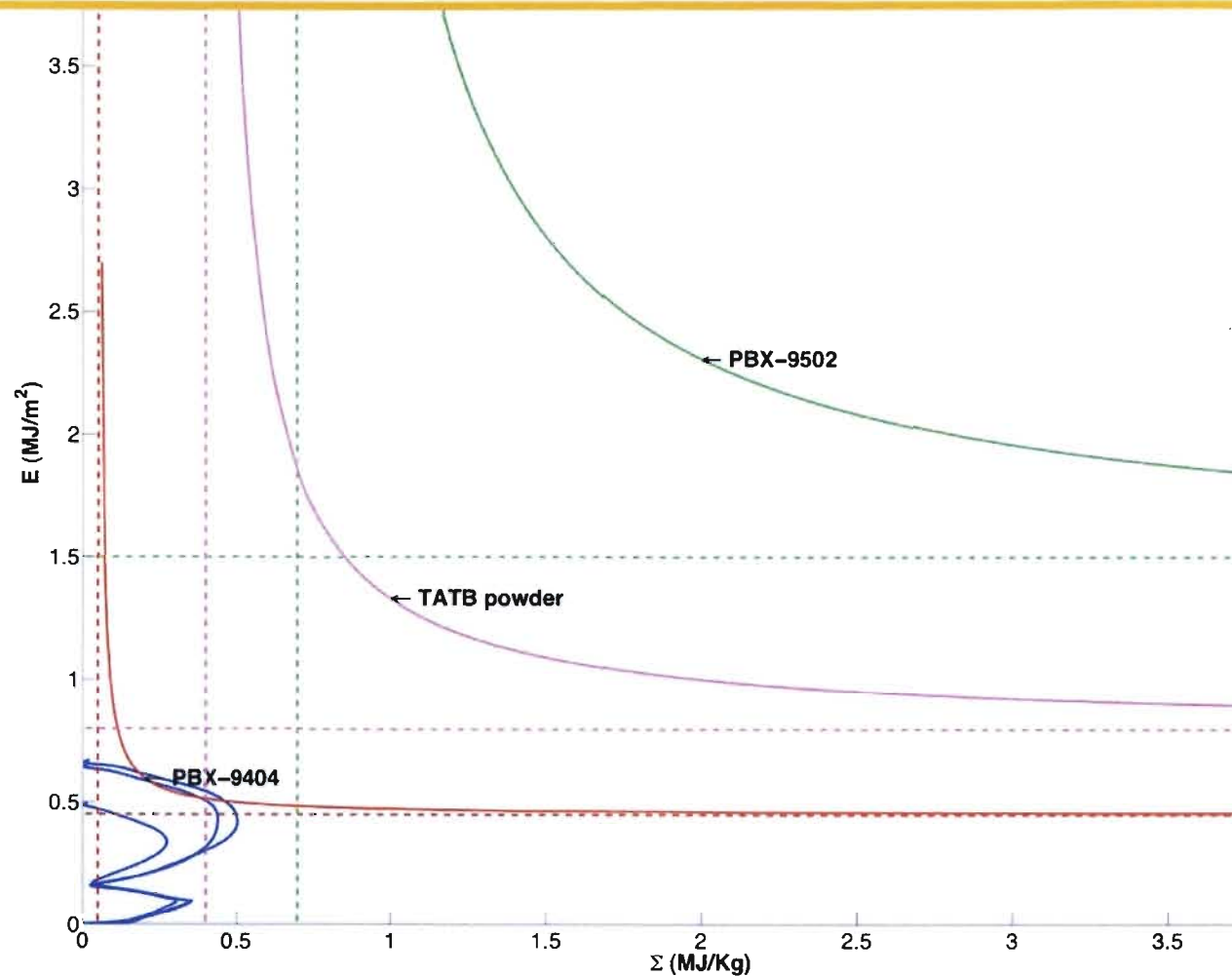


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## 7 Point Interaction Detonator- Single Points

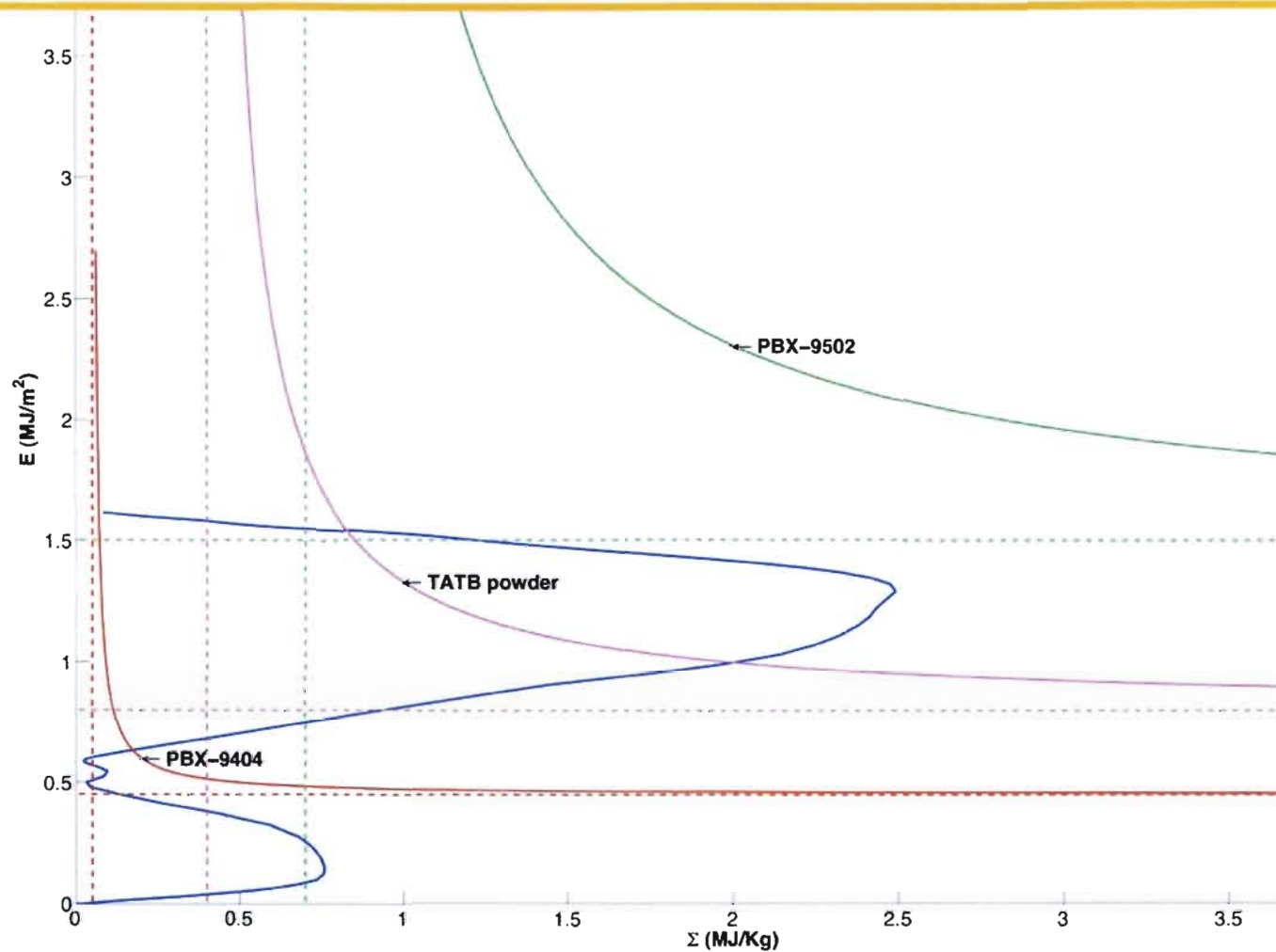


## 7 Point Interaction Detonator- Double Points





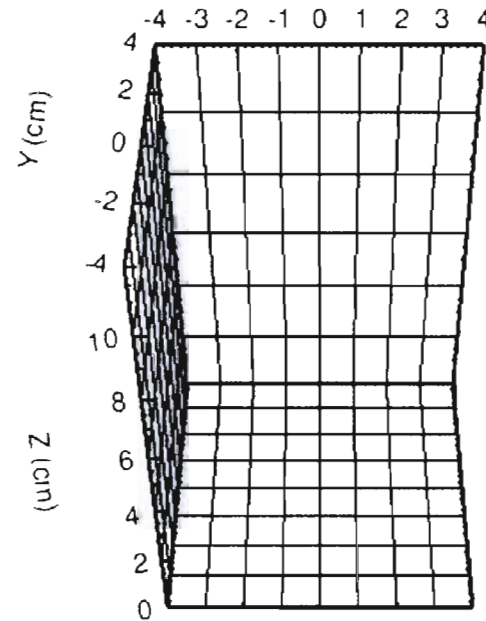
## 7 Point Interaction Detonator- Triple Point





## Continuing work

- Detonator characterization
  - Single detonator shots with PDV and Schlieren into air and PMMA
- Cut back shots with PDV
  - Verify the state at various depths into HE layer
- Gap tests to determine  $E_c$  –  $\Sigma_c$ 
  - Improved understanding of safety and performance margins
- Additional calculations as discussed to leverage Prad data etc.



## Acknowledgments

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- Frank Cherne, Cluster Administrator, Linux/bash scripting guru
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- W-6