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Title: The Los Alamos Gap Stick Test

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The Los Alamos Gap Stick Test

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June 18, 2015

Traditional Gap Test

- Samples detonation re-initiation across an inert barrier, the thickness of which is varied from shot-shot to find the critical value
- Practically defined as that for which re-initiation occurs in 50% of cases
- Ubiquitous with many variants
  - Popularity derived largely from its ease of fielding, as it uses only an witness plate as a go/no-go indicator
- Although the gap test is mechanically simple, its detonation re-initiation processes are somewhat more complex, involving curved, short shocks

Gap Test: Advantages

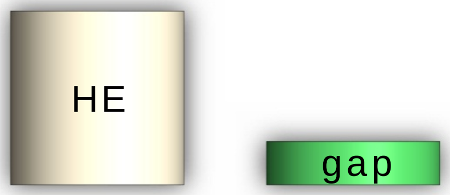
- Requires no instrumentation
- Can be (and is) scaled to work with explosives of any sensitivity
- Works well with CHE, where as other sensitivity tests such as corner turning, failure cone, and failure diameter/thickness, were designed for use with IHEs.

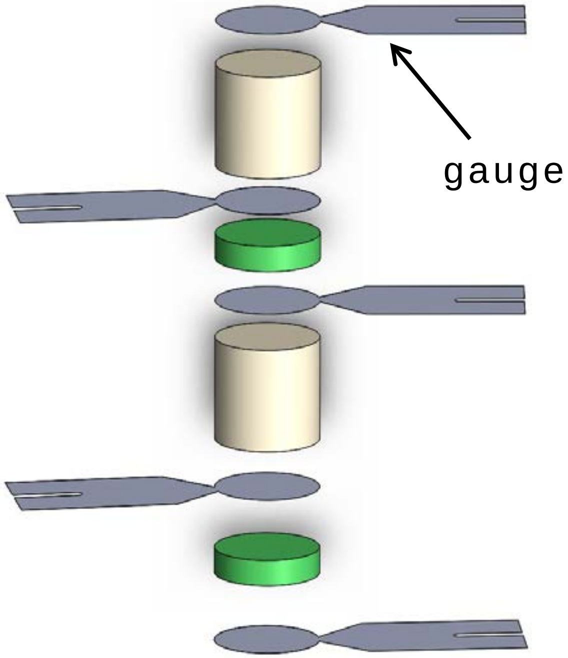
Gap Test: disadvantages

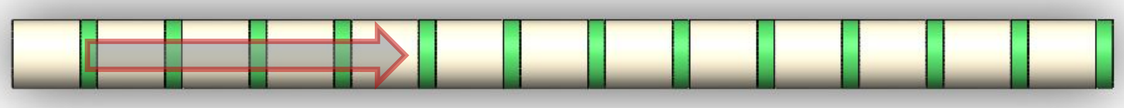
- The gap test is information-poor; multiple tests must be fired to obtain a single metric (the 50% thickness)
- Many test must be fired to obtain its value to high precision
- Gap Test designs have tended to be somewhat "sloppy," with ambiguous boundary conditions and other features
  - For example, if the stimulus is a detonator, one must ask how repeatable are the detonators that are used? If one wishes to calculate such a gap test, then one must also calculate detonator function, which is not necessarily easy

Gap Stick Test (GST)

- Our solution is a test wherein multiple gap tests are joined in series to form a rate stick
- We measure the shock arrival time before and after each inert barrier, and compute the average speed through the HE alone (discounting the gap thickness)
- We then plot the propagation speed as a function of gap thickness as a *Diameter Effect* (DE) curve
- And like the DE curve, terminates at a failure point







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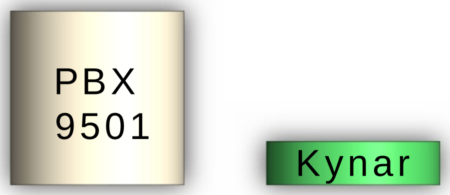
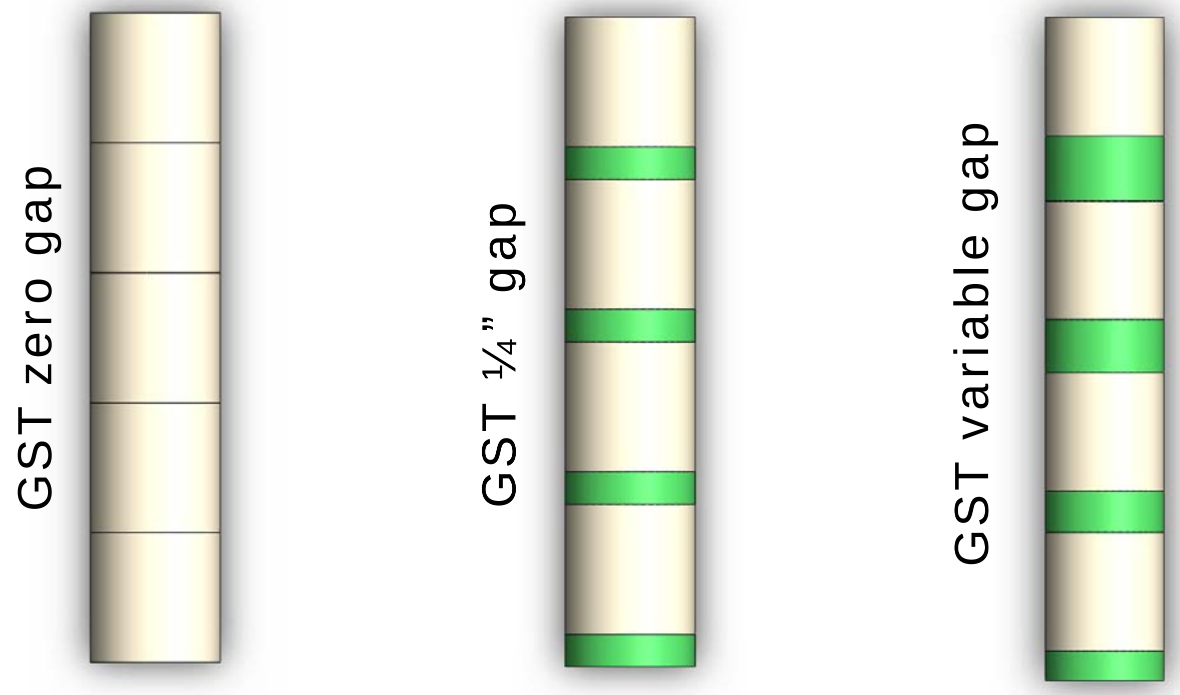
Experimental Setup



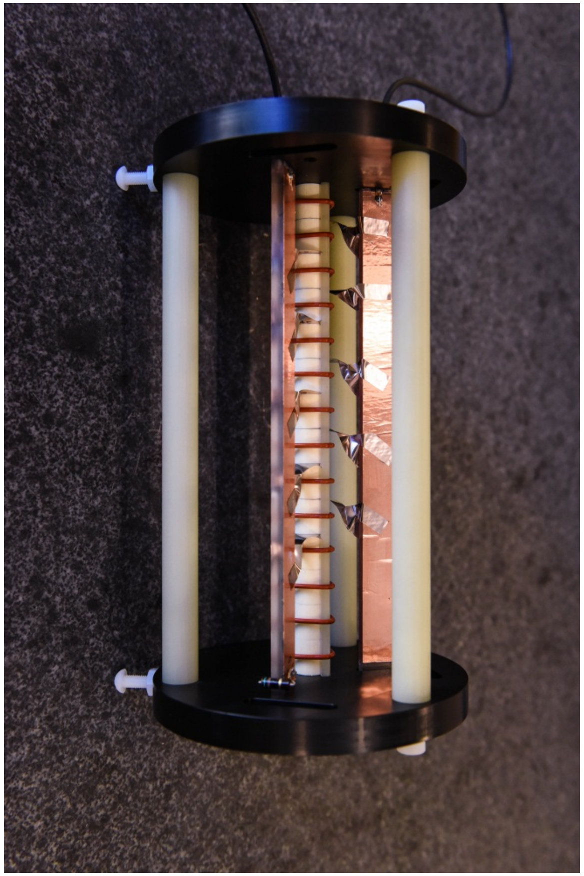
- HE: Die-pressed PBX 9501
- gap: Kynar type 740
  - Kynar has almost identical shock properties to most HEs (more so than any other plastic that we know of), which makes for simpler behavior.
- PVDF embedded gauges (Kynar)
  - ~1.3 mil thick
  - added to gap thickness

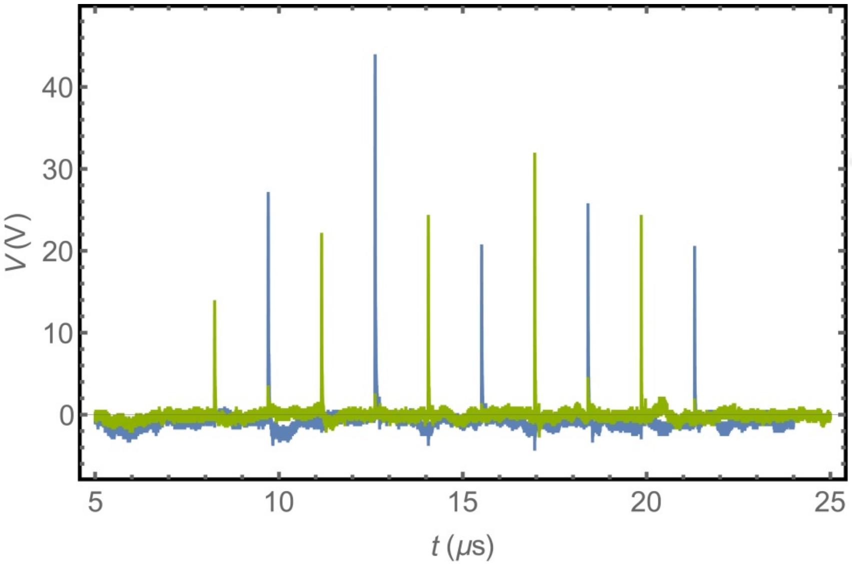
Experiment Execution

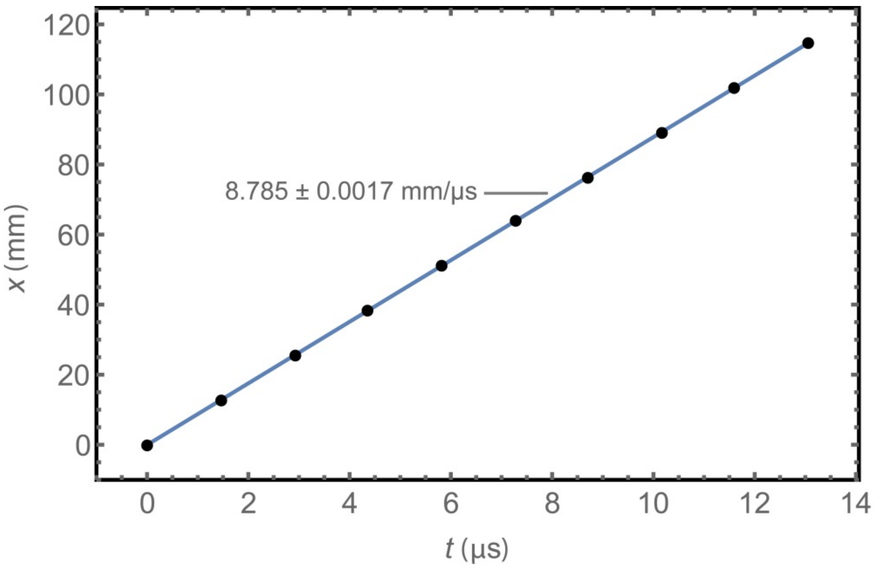
- 3 configurations



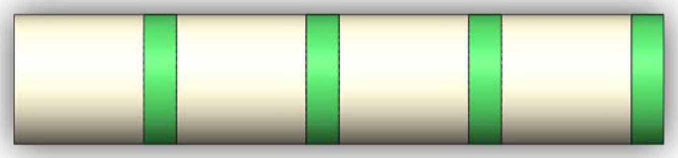
GST zero gap

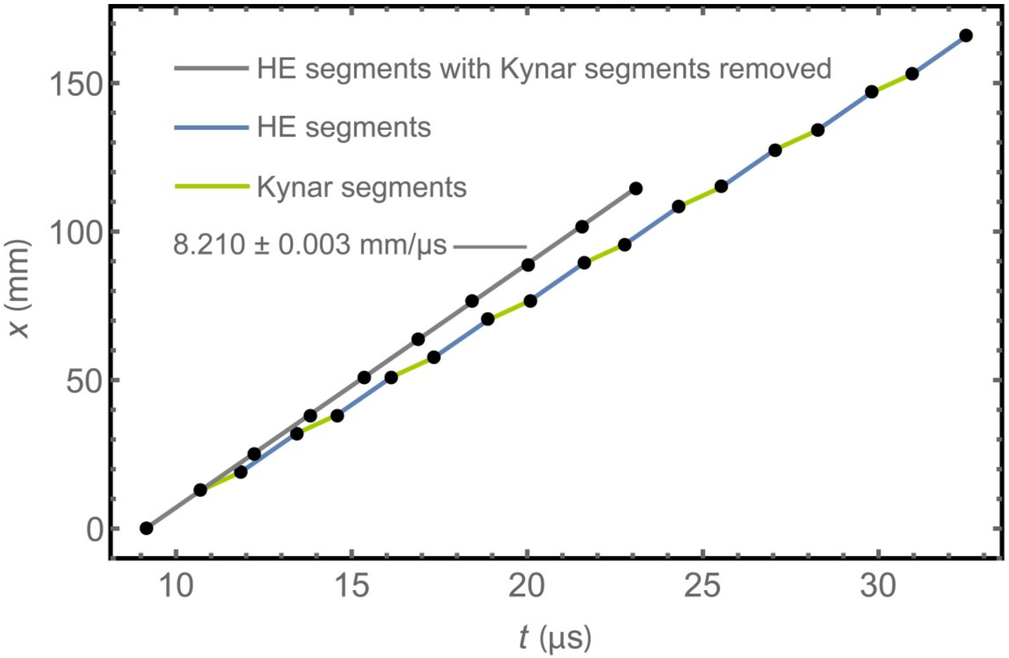



V (V)
40
30
20
10
0
5
10
15
20
25
t (μs)

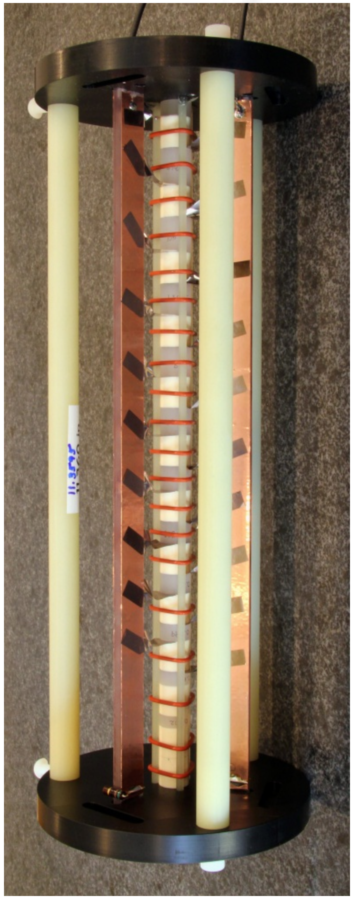

x (mm)
120
100
80
60
40
20
0
2
4
6
8
10
12
14
t (μs)
8.785 ± 0.0017 mm/μs

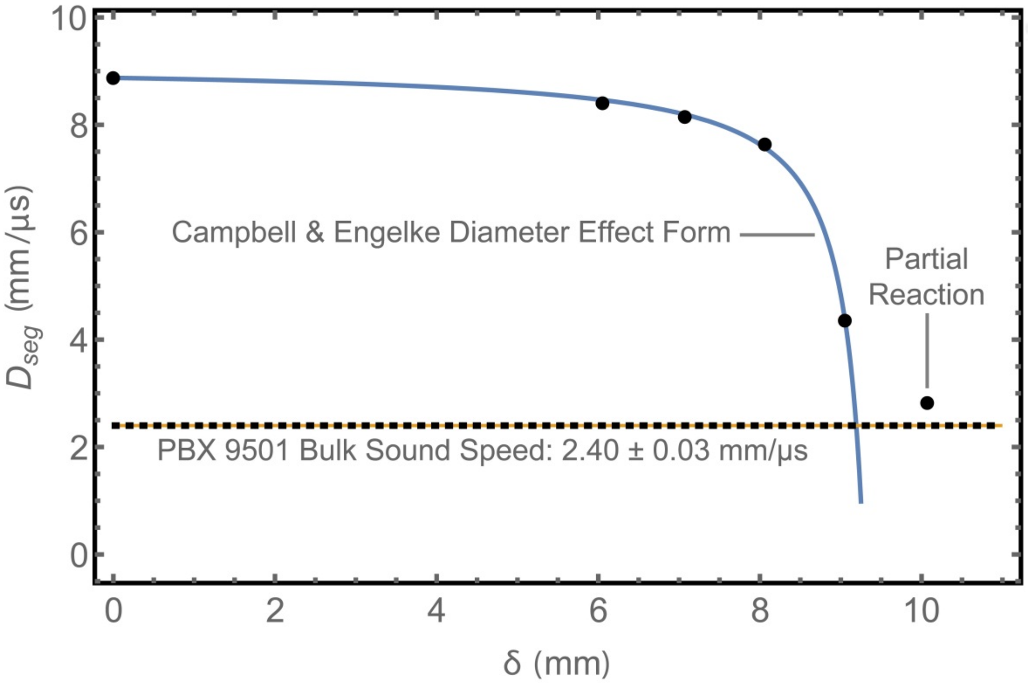
GST ¼” gap



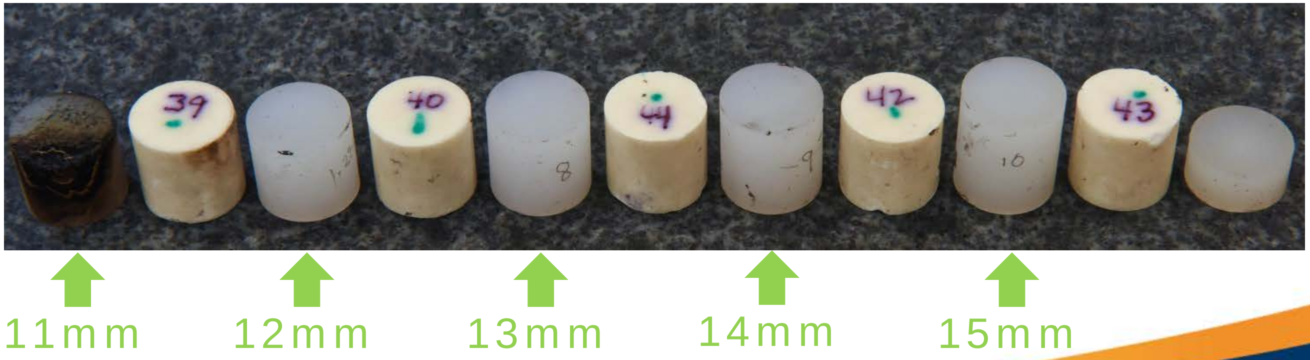

HE segments with Kynar segments removed
HE segments
Kynar segments
8.210 ± 0.003 mm/μs
x (mm)
t (μs)
0
50
100
150
10
15
20
25
30

GST variable gap





Recovered pellets



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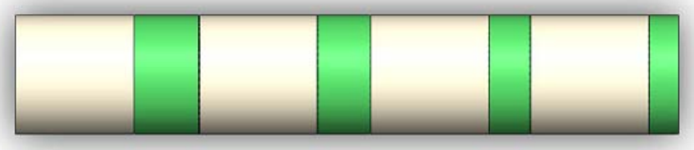
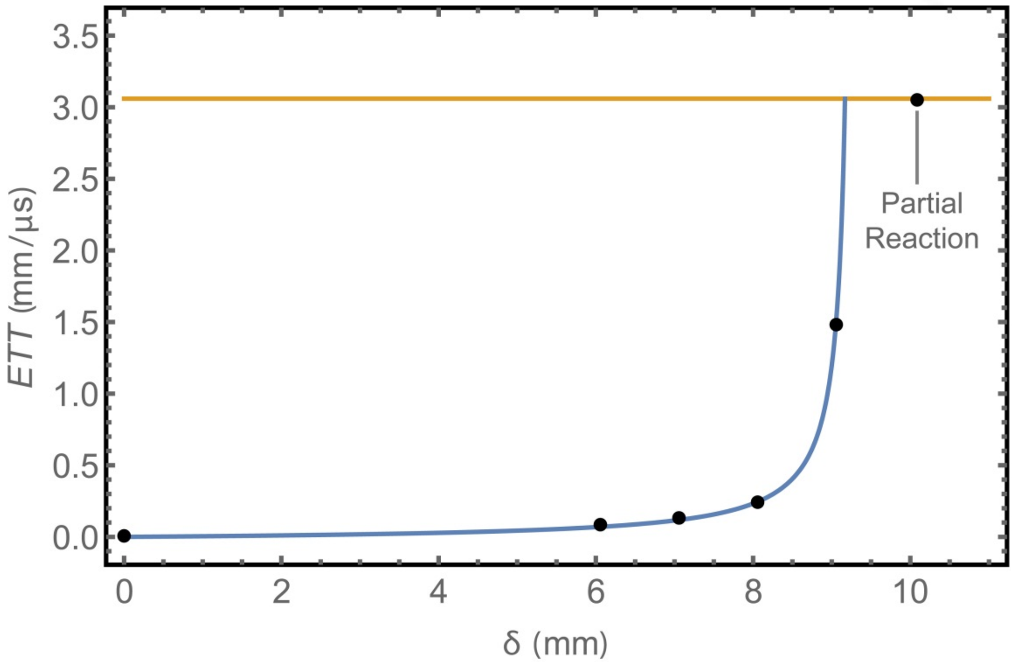
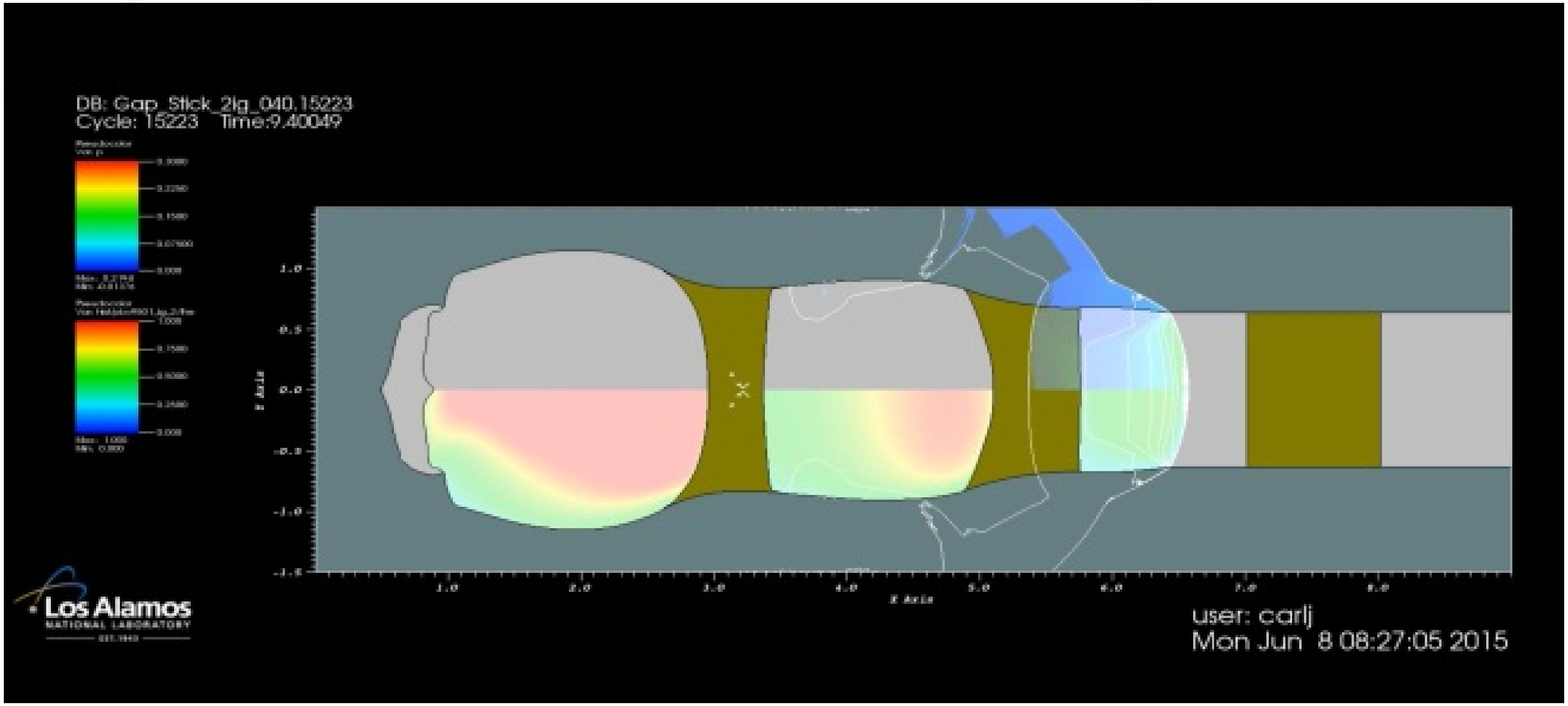
GST variable gap





*Excess Transit time (ETT)

Simulation



DB: Gap_Stick_2ig_040.15223
Cycle: 15223 Time:9.40049
Los Alamos
NATIONAL LABORATORY
user: carlj
Mon Jun 8 08:27:05 2015

Conclusion

- GST is proven reliable with the Explosive PBX 9501
- PVDF embedded gauges provide a resolution of order 1%
- GST is more data rich in comparison to the traditional gap test
- GST can be easily scaled to the reaction zone thickness of any explosive