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RDECOM

Modeling Fragmentation Performance of Insensitive Explosive Fragmentation Munitions

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TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

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Outline

- Introduction: Overview of the PAFRAG (Picatinny Arsenal FRAGmentation) Modeling Methodology
- Modeling Fragmentation Performance of Insensitive Explosive Fragmentation Munitions
- Summary

PAFRAG Modeling Methodology

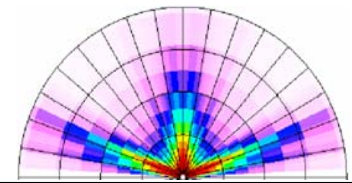
Expensive

Fragmentation Arena Testing

Z-data

CALE → **PAFRAG**

PAFRAG Modeling



CASRED/ALGRID

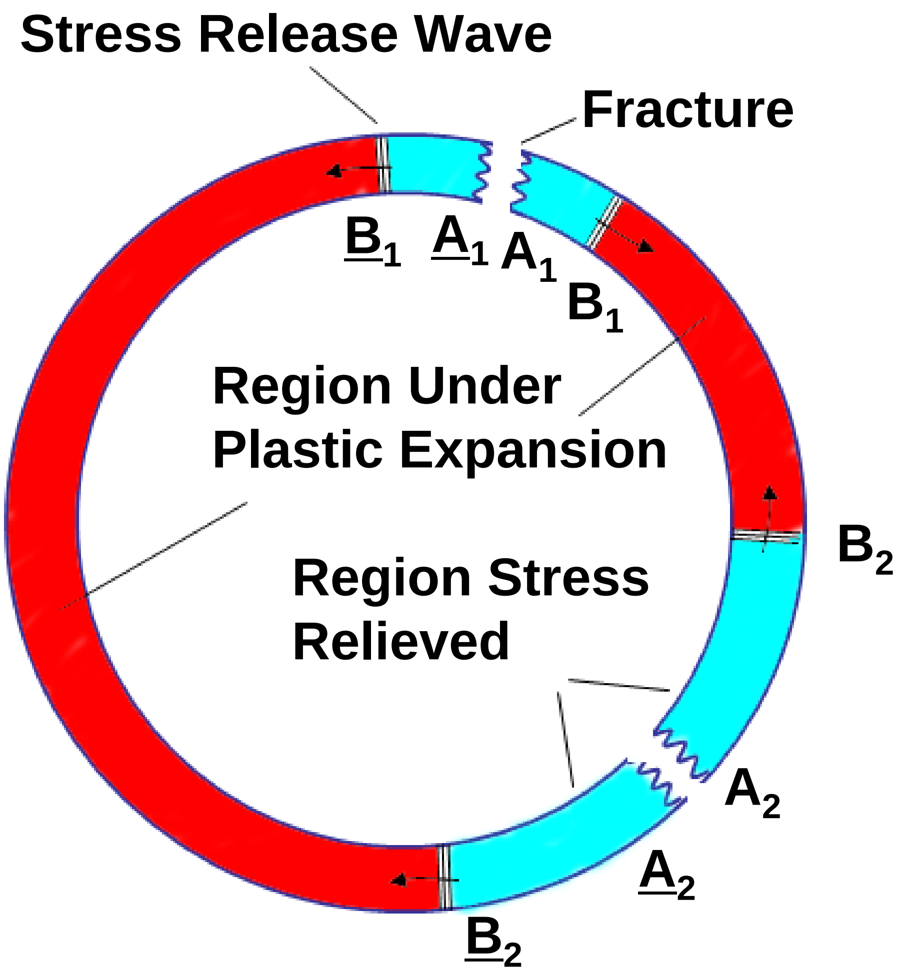
Lethality Modeling

Inexpensive

CALE	PAFRAG – Picatinny Arsenal Fragmentation code	CASRED/ALGRID
Dynamic high-strain high strain rate continuum analyses	Fragmentation modeling	Lethality Codes Model the effectiveness of the munition

Natural Fragmentation: PAFRAG-MOTT Model

Based on Mott's theory of break-up of cylindrical "ring-bombs"



Average circumferential fragment length:

$$x_0 = \left(\frac{2P_F}{\rho\gamma}\right)^{1/2} \frac{r}{V}$$

Average fragment mass:

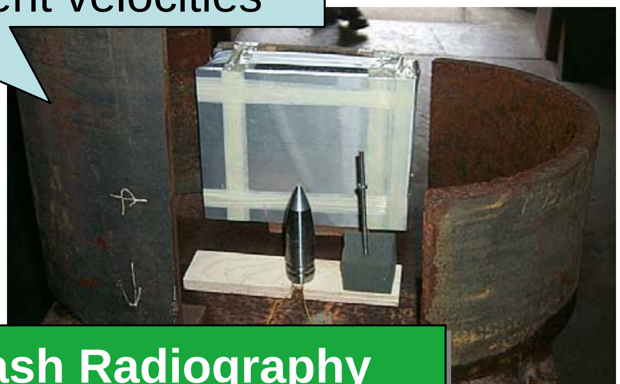
$$\mu = \frac{1}{2}\rho x_0^3$$

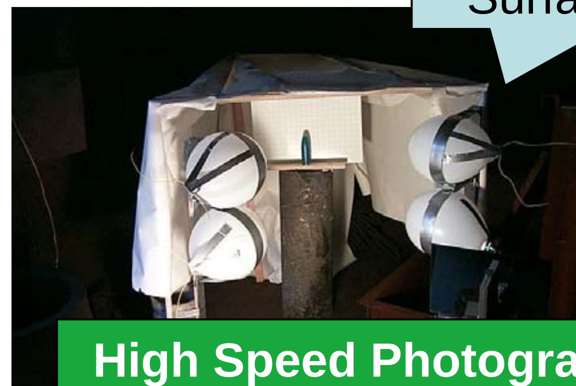
Fragment size distribution:

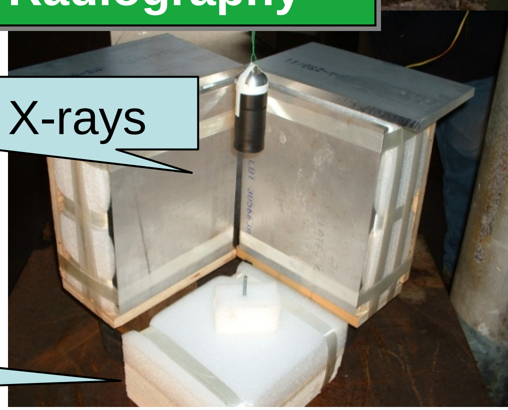
$$N(m) = N_0 e^{-\left(m/\mu\right)^{1/2}}$$

γ is a statistical parameter and can be determined from fragmentation test data

PAFRAG Experimentation



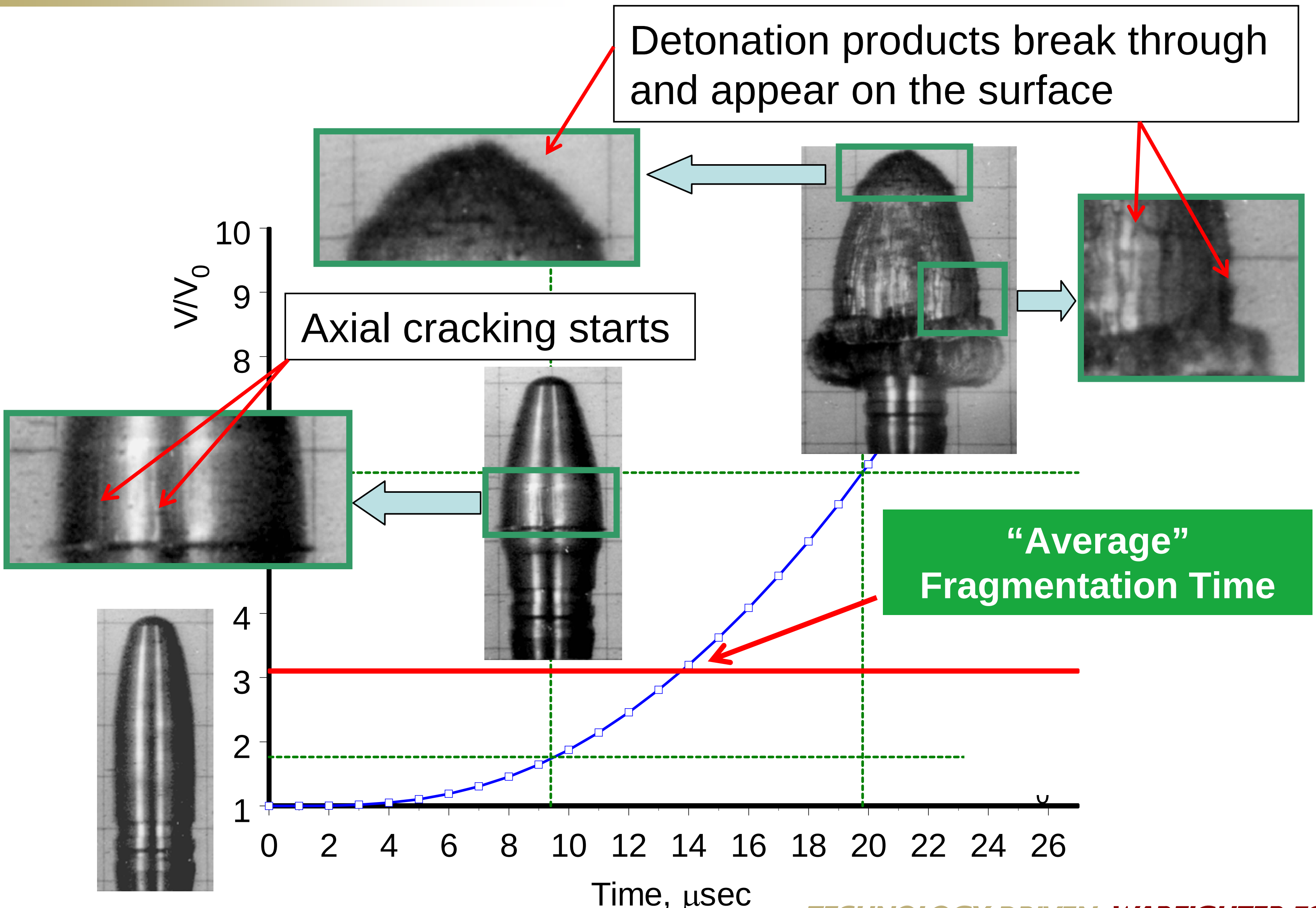




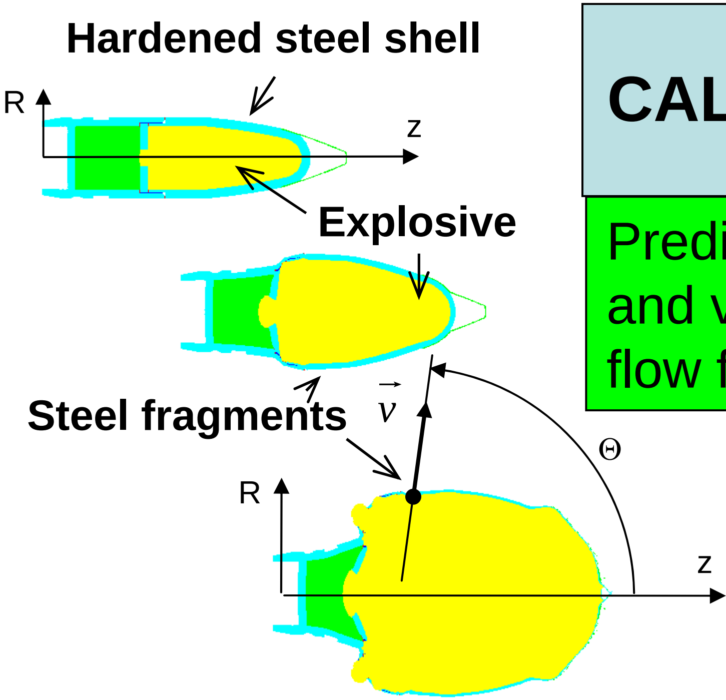
Final munitions require arena testing

PAFRAG experimentation is adjusted according to specific project/customer needs

V/V$_0$ vs Time and High Speed Photography



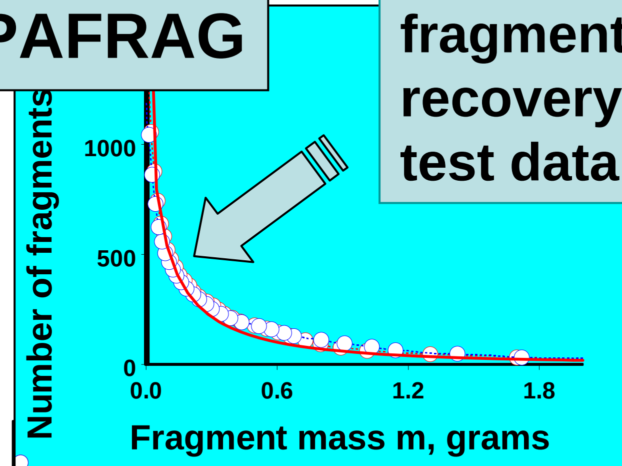
PAFRAG Modeling Methodology for Lethality Assessments



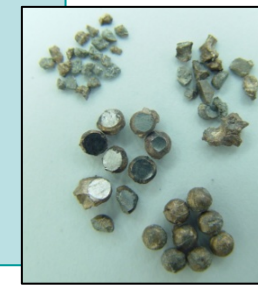
CALE

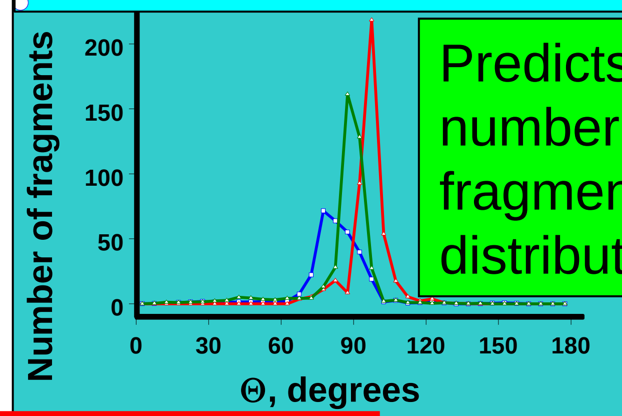
PAFRAG

Predicts mass and velocity flow field



Sawdust fragment recovery test data

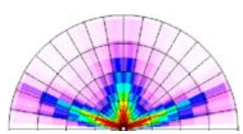




Predicts number of fragment distributions

PAFRAG modeling and experimentation

Z-data



Predicts Lethality

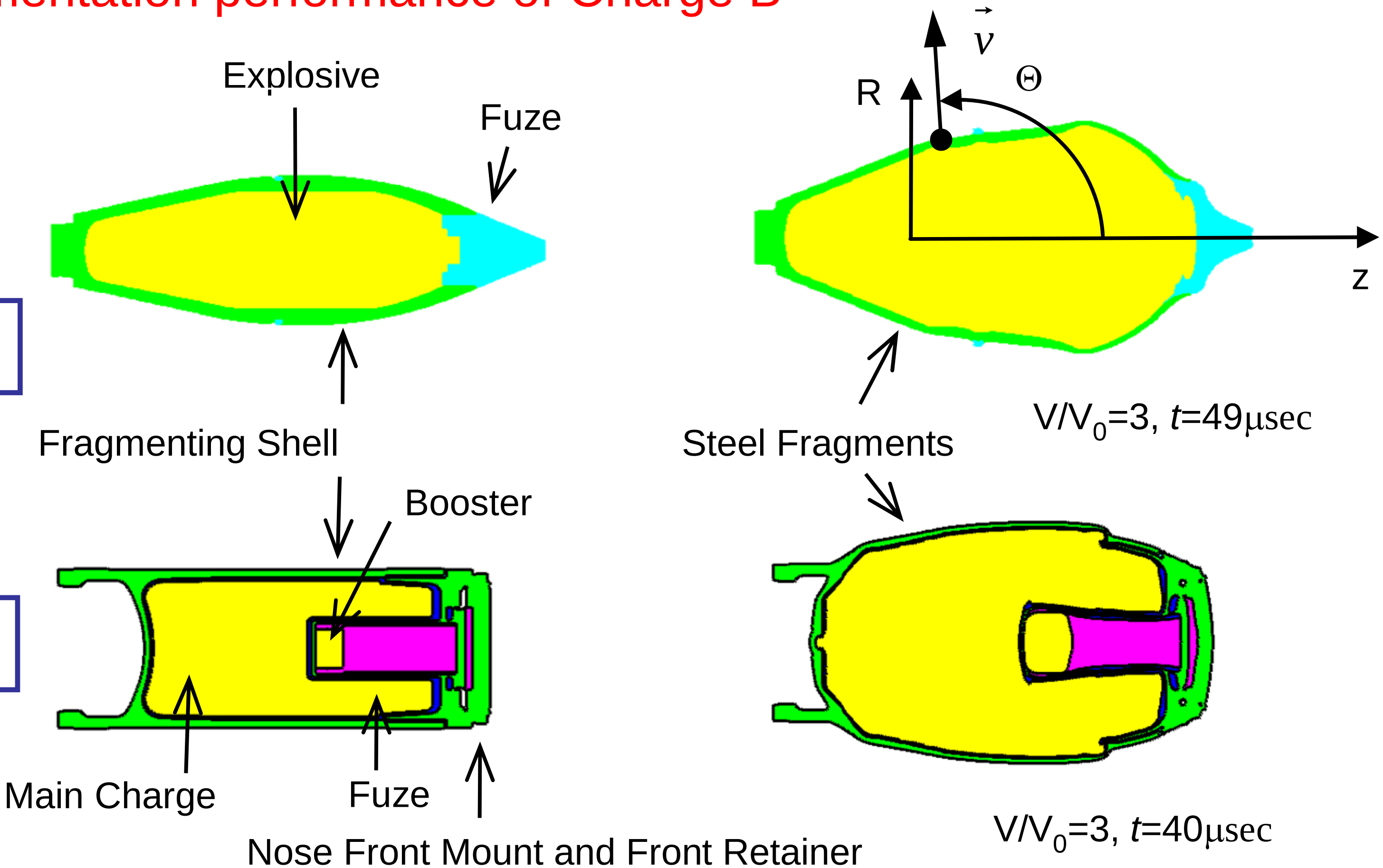
CALE-PAFRAG Modeling

Given: Fragmentation performance of Charge A

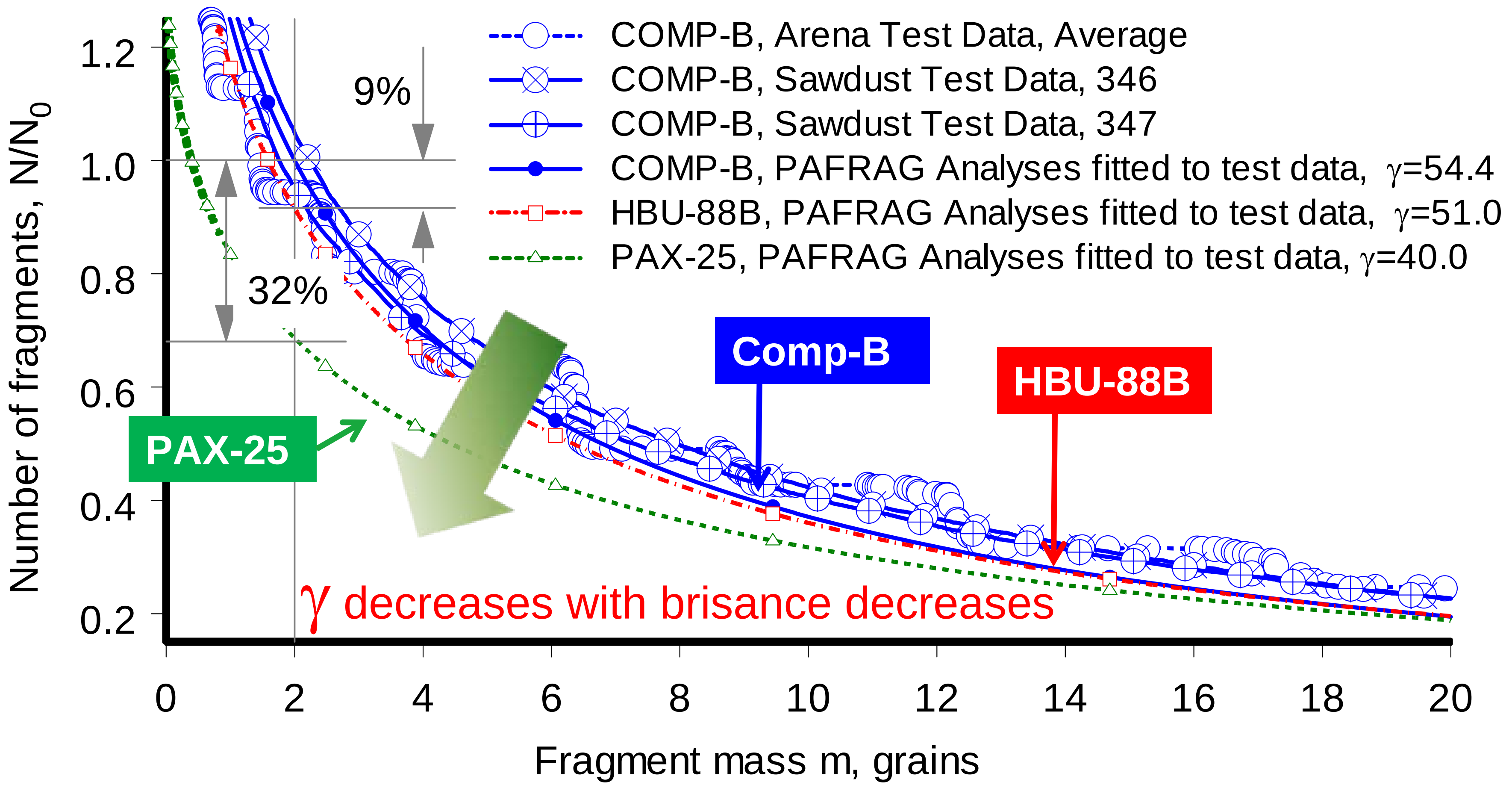
Find: Fragmentation performance of Charge B

Charge A

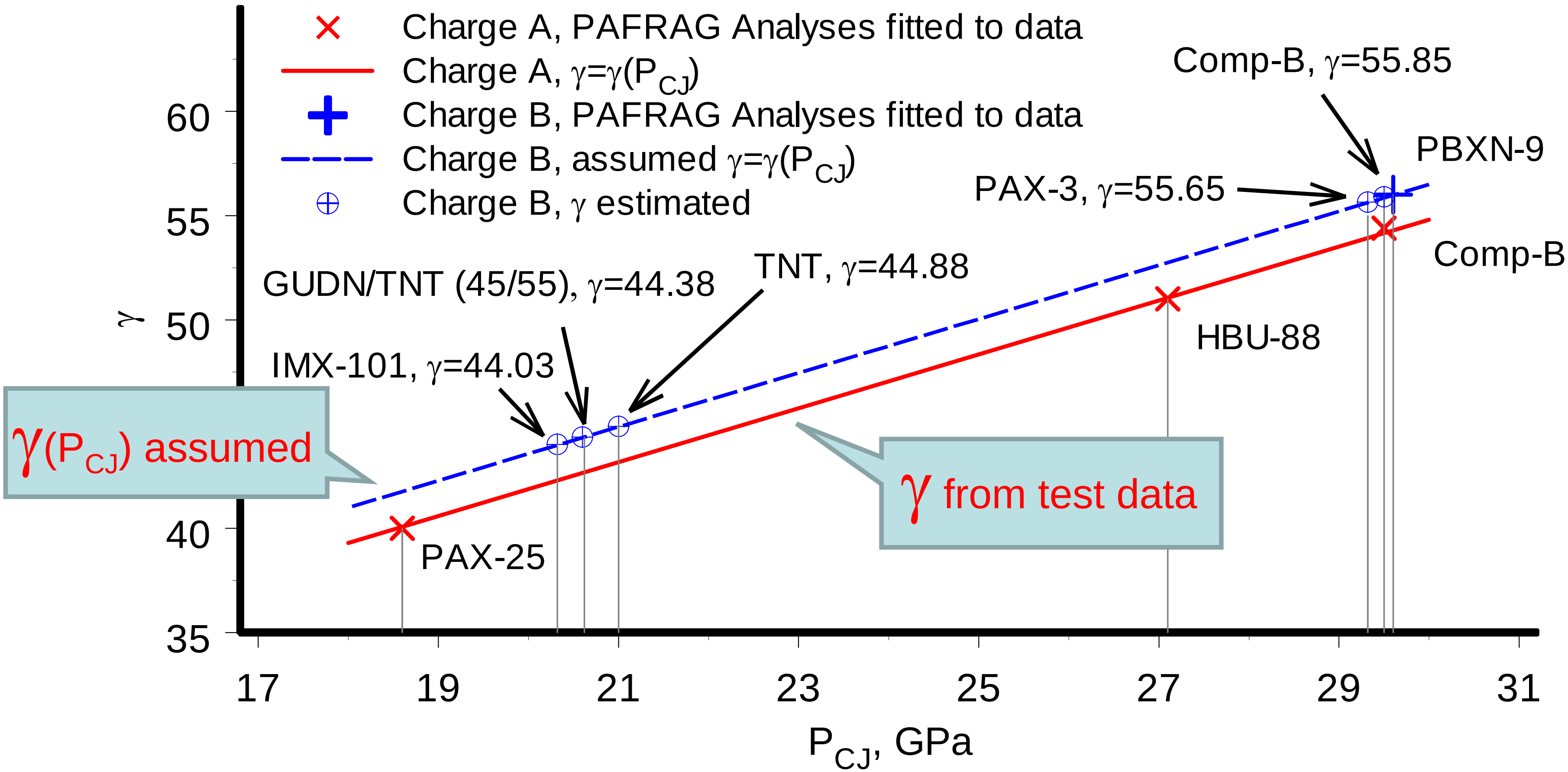
Charge B



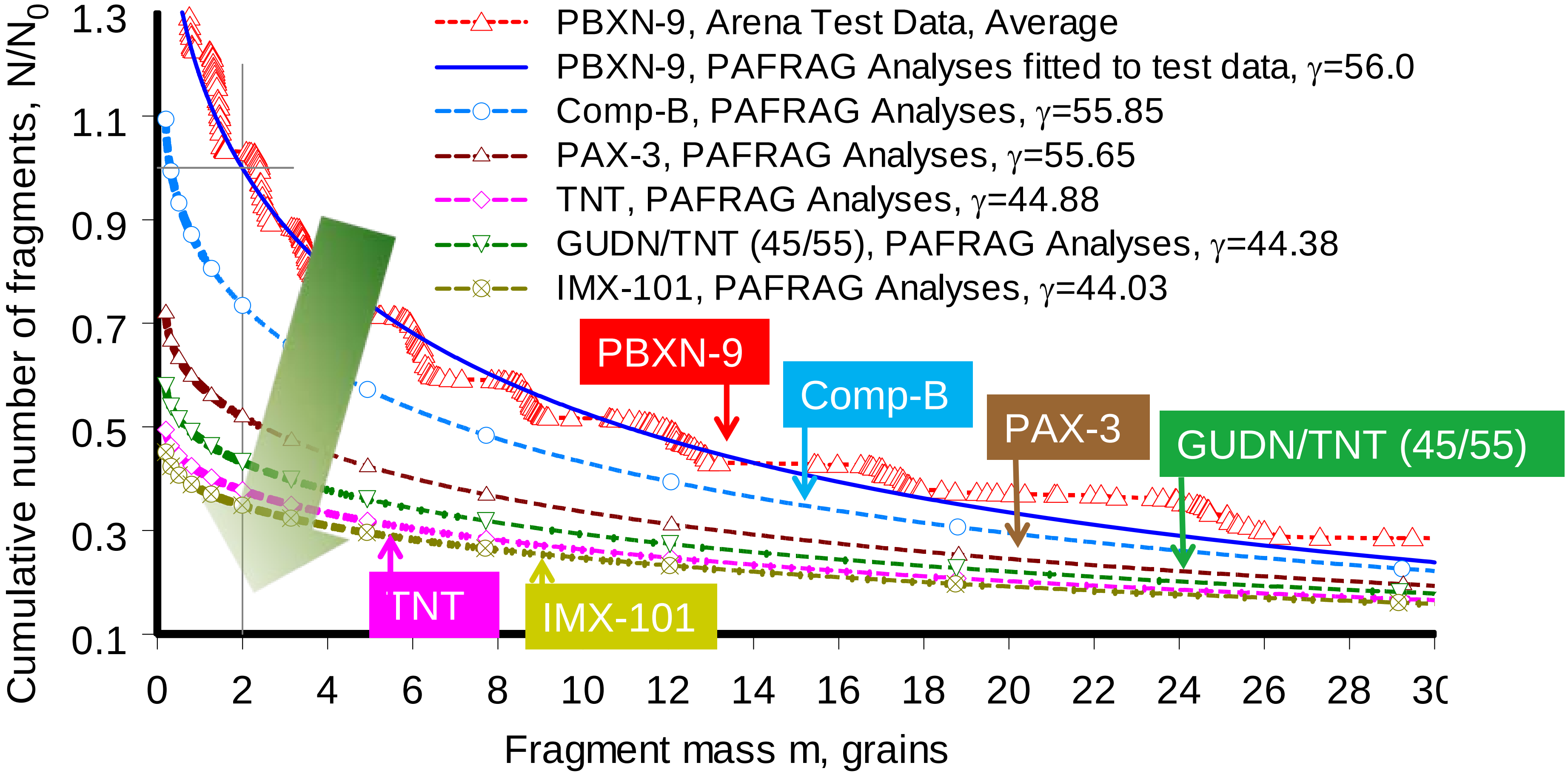
Cumulative number of fragments versus fragment mass, Charge A



Parameter γ versus explosive detonation Chapman-Jouguet (CJ) pressure

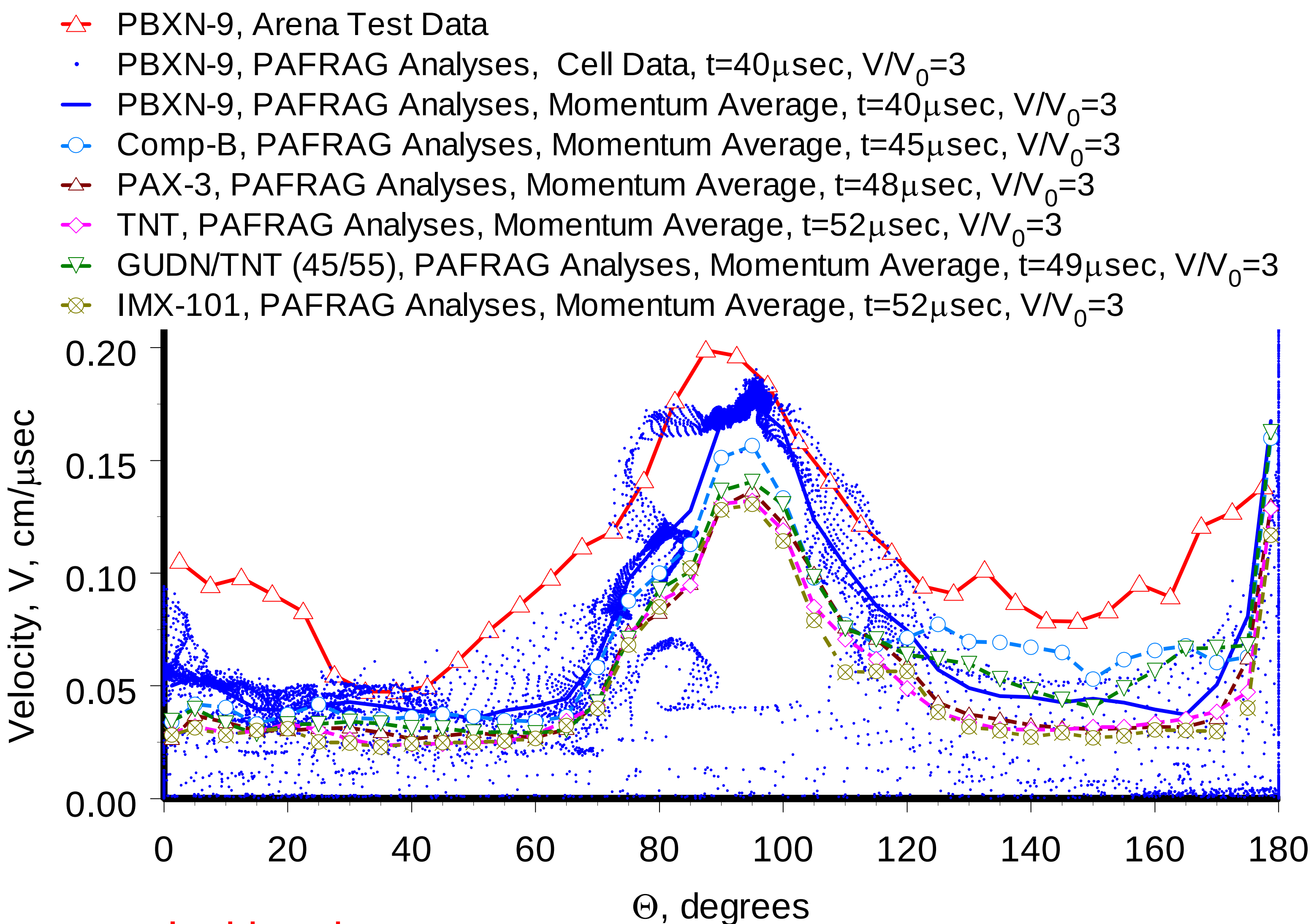


Cumulative number of fragments versus fragment mass, Charge B



P_{CJ} decreases, γ decreases, fragmentation performance degrades

Fragment velocities versus theta for varying explosive compositions, Charge B



Fragment velocities decrease

Summary

- ✓ New modeling methodology for assessing performance of IM munitions developed
- ✓ Employing IM explosives with low brisance properties and low Chapman-Jouguet (CJ) pressures leads to decreases in the fragment numbers and velocities
- ✓ Based on the experimental data available to-date, an approximately linear relationship between the γ-parameter and the Chapman-Jouguet (CJ) detonation pressures is observed
- ✓ To maintain lethality requirements, explosive fragmentation munitions with IM formulations requires employing high fragmentation steel alloys, or controlled/preformed fragmentation techniques, or a combination of thereof

Questions?

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Back-up slides