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Significant Charge Parameters influencing the Shaped Charge Jet Initiation

Dr. Werner Arnold
Ernst Rottenkolber(*)

2013 INSENSITIVE MUNITIONS & ENERGETIC MATERIALS TECHNOLOGY SYMPOSIUM

MBDA
MISSILE SYSTEMS
(*) NUMERICS

Referenced Studies (IMEMTS & HVIS)

IMEMTS 2007, Miami, USA
"Sensitivity of High Explosives Against Shaped Charge Jets"

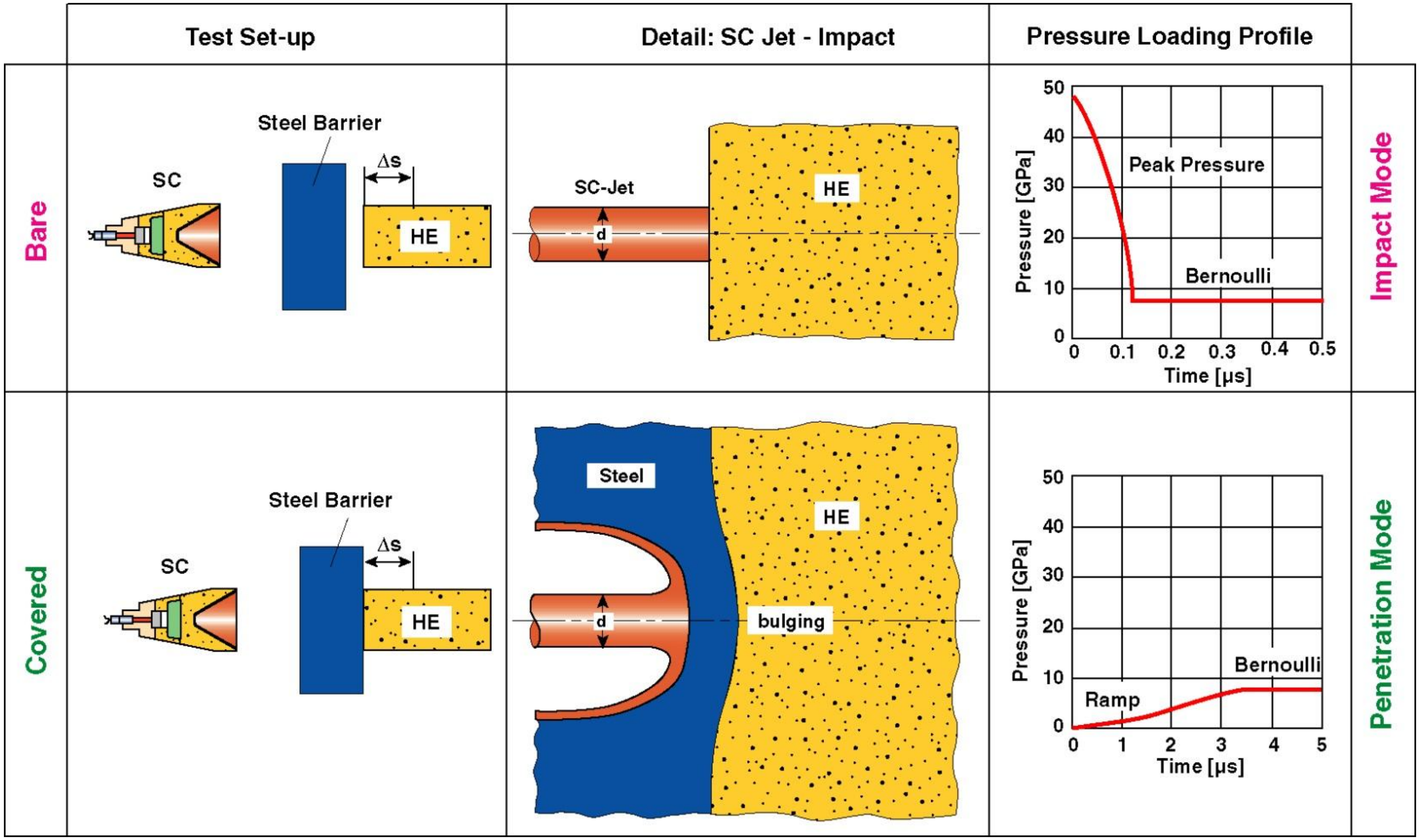
IMEMTS 2010, Munich, Germany
"Shaped Charge Jet Initiation of High Explosives equipped with an Explosive Train"

IMEMTS 2012, Las Vegas, USA
"Shaped Charge Jet Initiation Phenomena of Plastic Bonded High Explosives"

Hypervelocity Impact Symposium (HVIS) 2010, Freiburg, Germany
"High Explosive Initiation by High Velocity Projectile Impact"

Hypervelocity Impact Symposium (HVIS) 2012, Baltimore, USA
"High Explosive Initiation Behavior by Shaped Charge Jet Impacts"

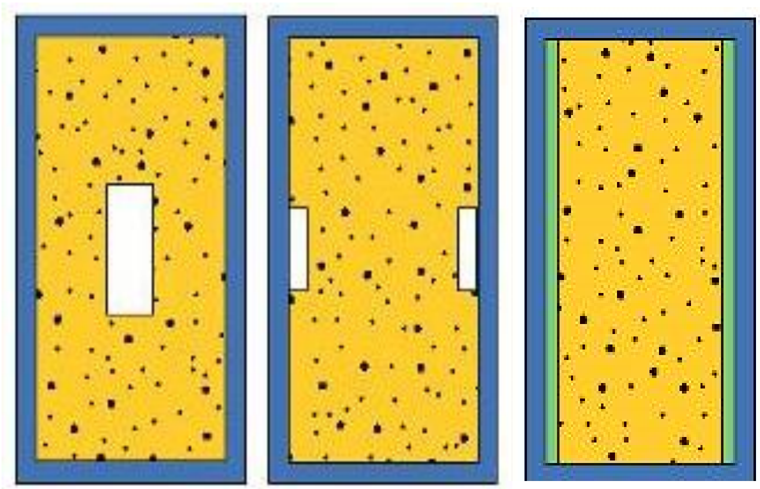
Basic Investigations: Initiation Modes



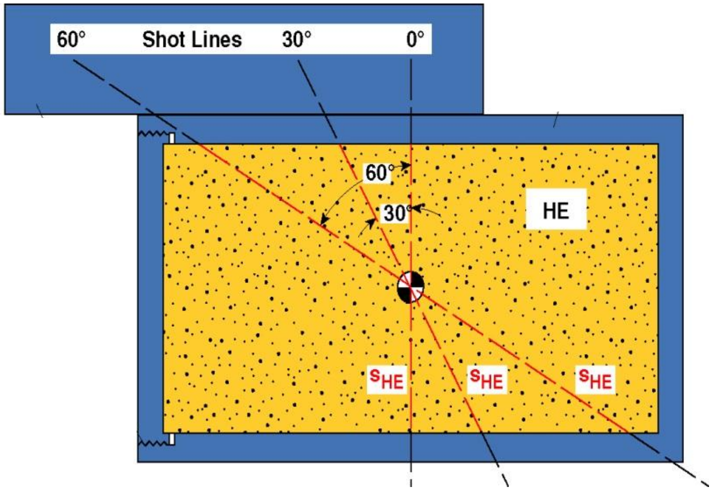
W. Arnold, E. Rottenkolber;
“Shaped Charge Jet Initiation Phenomena of Plastic Bonded High Explosives”, IMEMTS 2012

W. Arnold, E. Rottenkolber;
“High Explosive Initiation Behavior by Shaped Charge Jet Impacts”, HVIS 2012

Significant Parameters: Voids, Air Gaps, Layers & Shot Line LOS



Voids, Air Gaps, Layers



Shot Line LOS

W. Arnold, E. Rottenkolber;
"Sensitivity of High Explosives Against Shaped Charge Jets", IMEMTS 2007

W. Arnold, M. Graswald;
"Shaped Charge Jet Initiation of High Explosives equipped with an Explosive Train", HVIS 2010

Outline

- Motivation
- Test Set-up and Measuring Technique
- Variation of Charge Parameters & Results
- Application to Real Munition
- Summary

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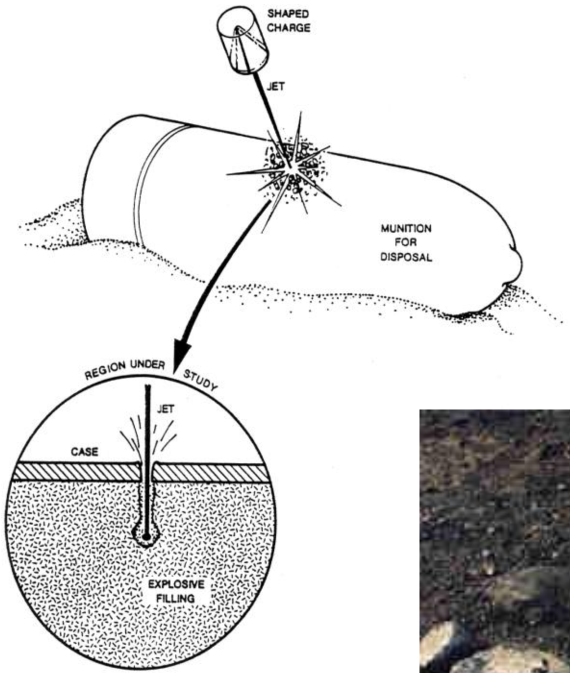
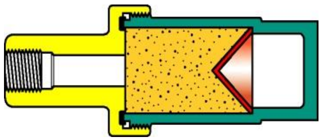
Explosive Ordnance Disposal (EOD) with Shaped Charge



EOD Shaped Charge



Outline

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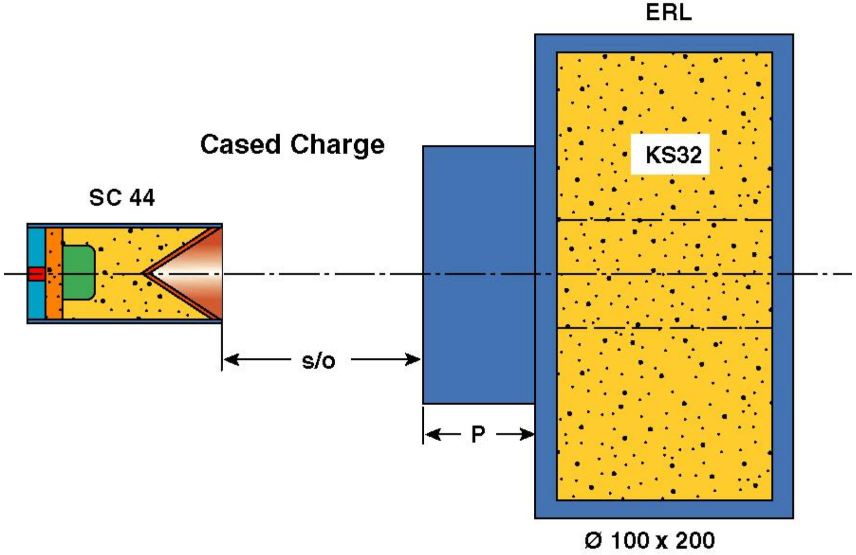
Test Set-ups: Bare & Covered and ***Cased***

Standard Charge

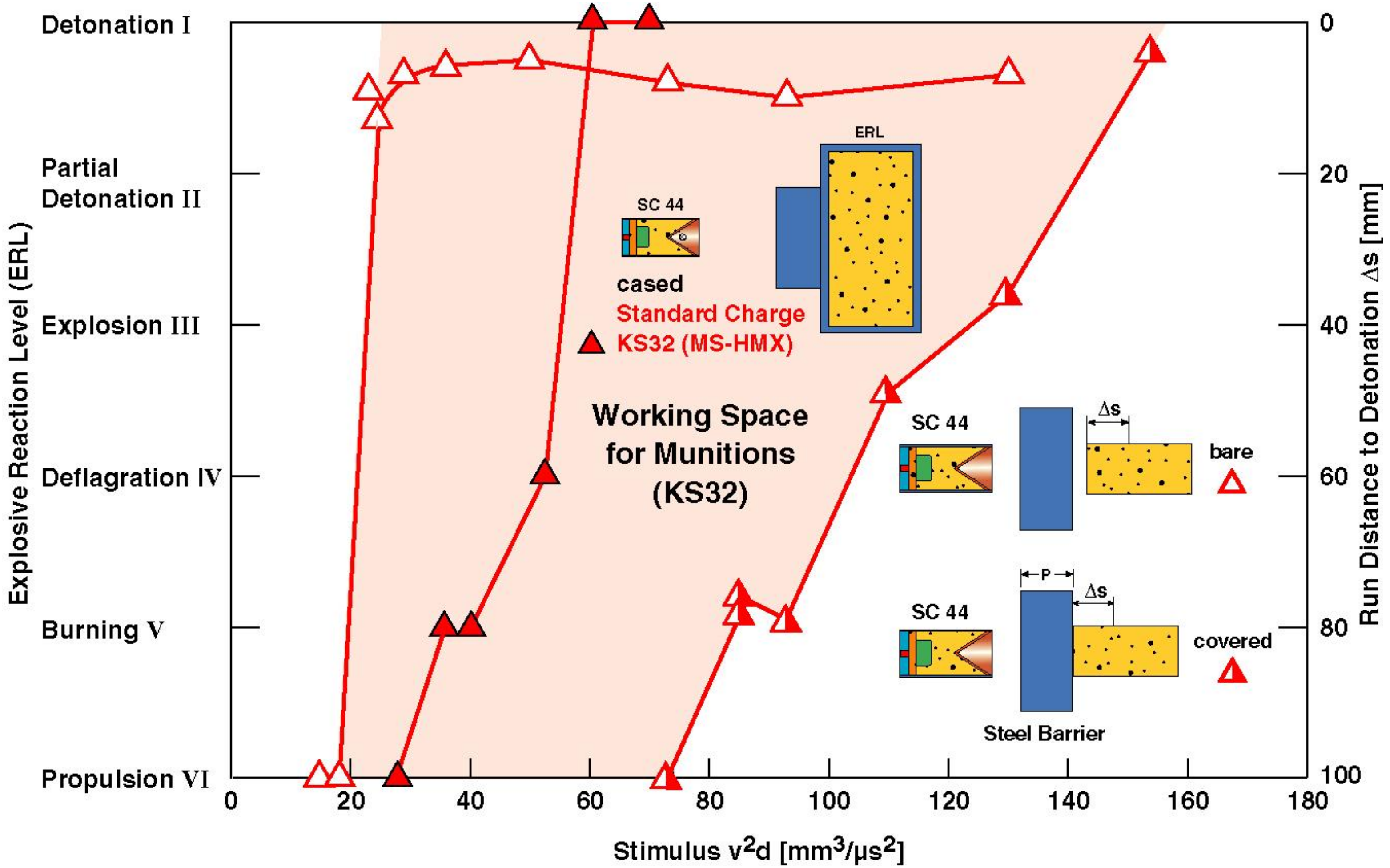
Standard Plastic Bonded HE

KS32
HMX/PB 85/15
ρ = 1.63 g/cm³



Typical Explosive Reaction Levels (ERL, MIL-STD)

Results for Standard Charge (Reference, IMEMTS 2007)



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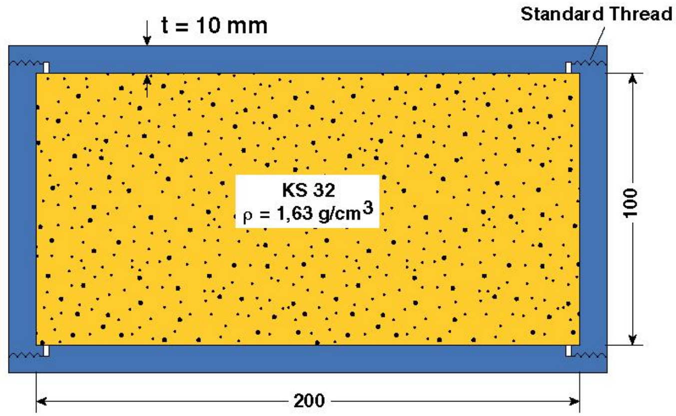
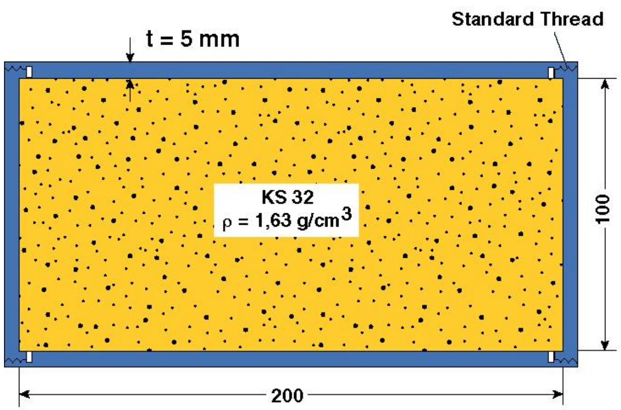
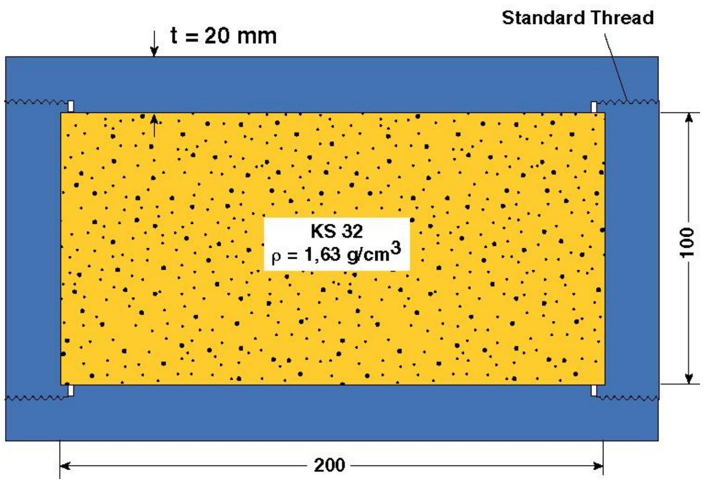
Casing Thickness and Material



t = 10 mm Mild Steel

Standard Charge

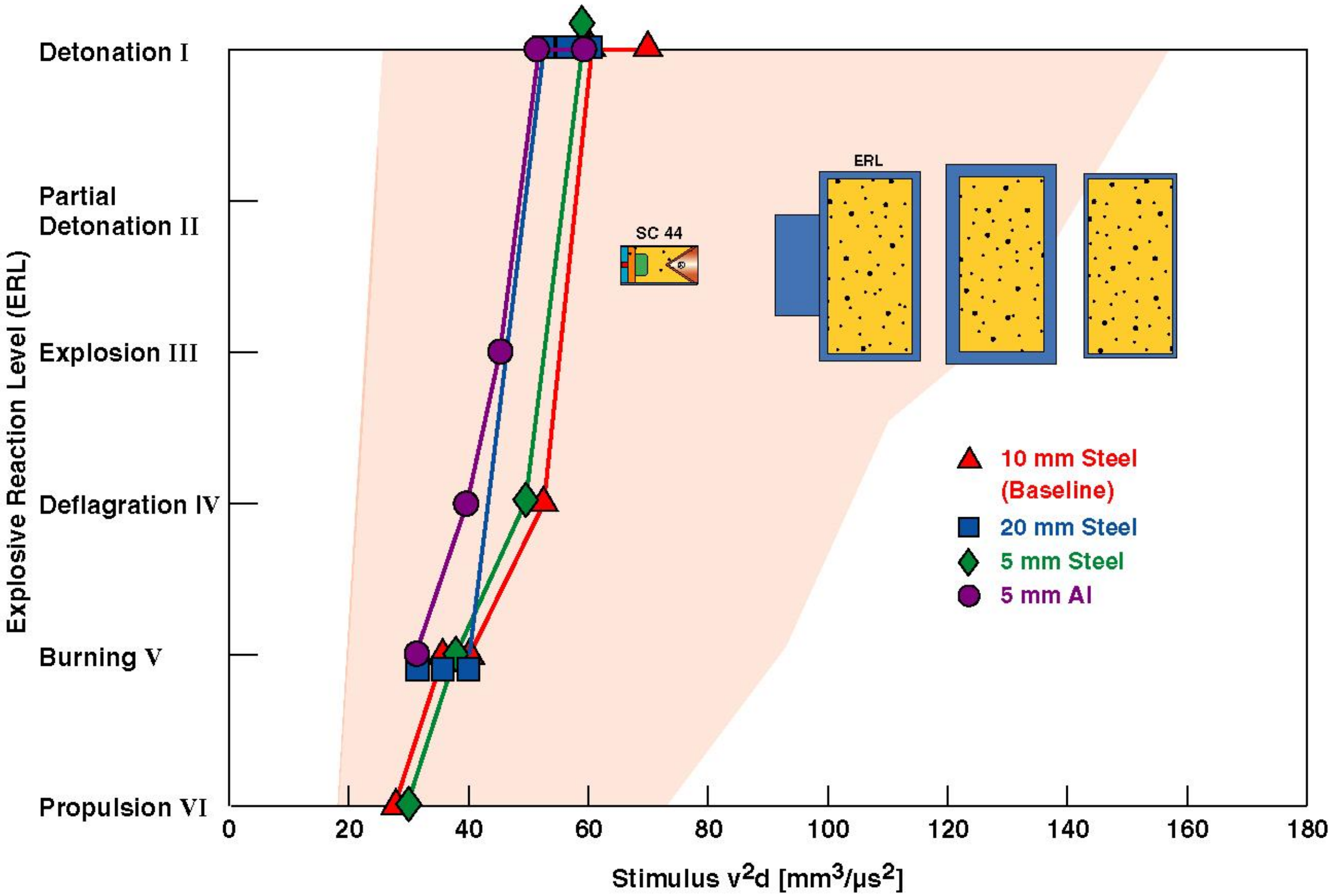




t = 5 mm Mild Steel or Al

t = 20 mm Mild Steel

Results: Casing Thickness and Material



- Increased sensitivity with increasing casing thickness
- Thin and low strength casing charges behave more and more like a “bare charge”

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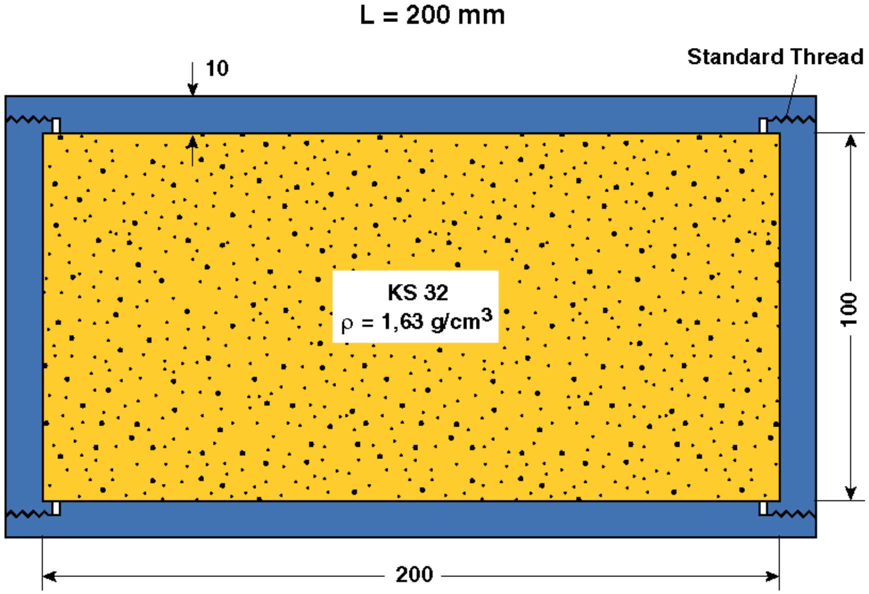
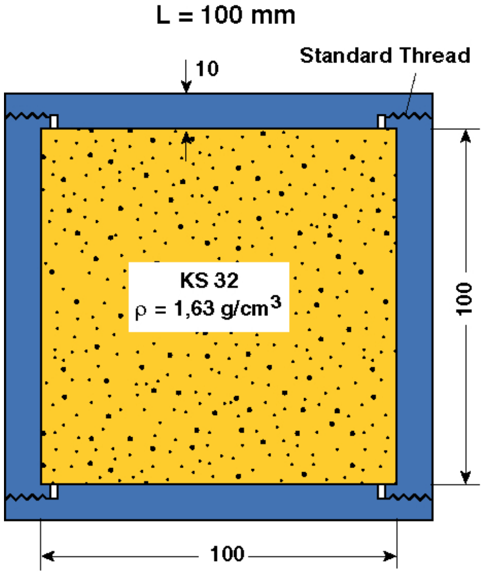
Length of Explosive Charge



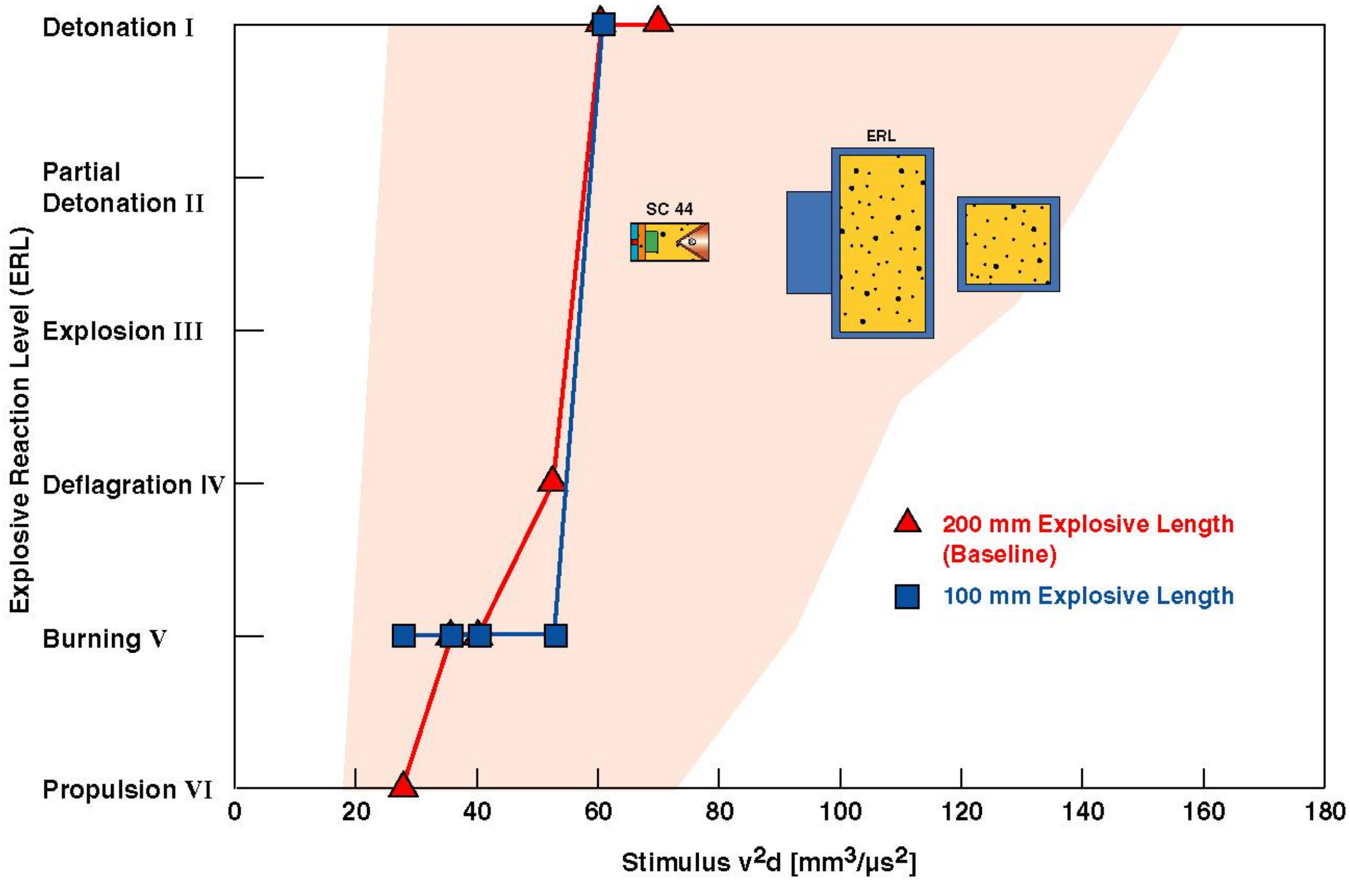


L = 200 mm HE

Standard Charge

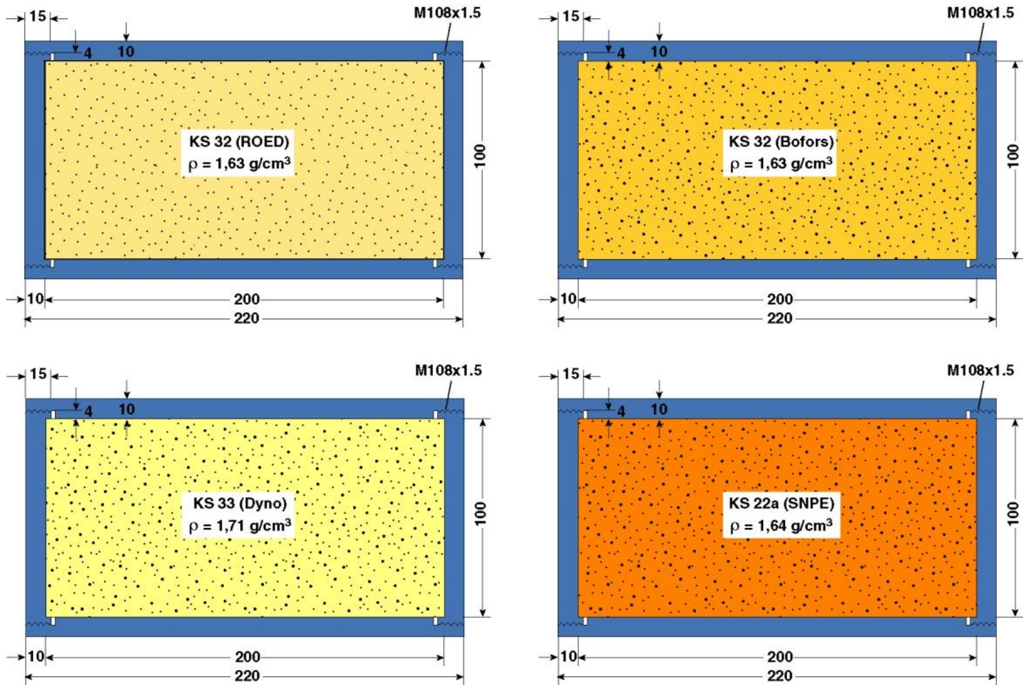
L = 100 mm HE

Results: Length of Explosive Charge



- **Influence of shortened distance to "weak spots" on sensitivity is negligible**

High Explosive Type



KS32 (MS-HMX/PB 85/15), ρ = 1.63 g/cm³ (Standard Charge)
KS32 (RS-HMX/PB 85/15), ρ = 1.63 g/cm³
KS33 (HMX/PB 90/10), ρ = 1.71 g/cm³
KS22 (RDX/Al/PB 67/18/15), ρ = 1.64 g/cm³

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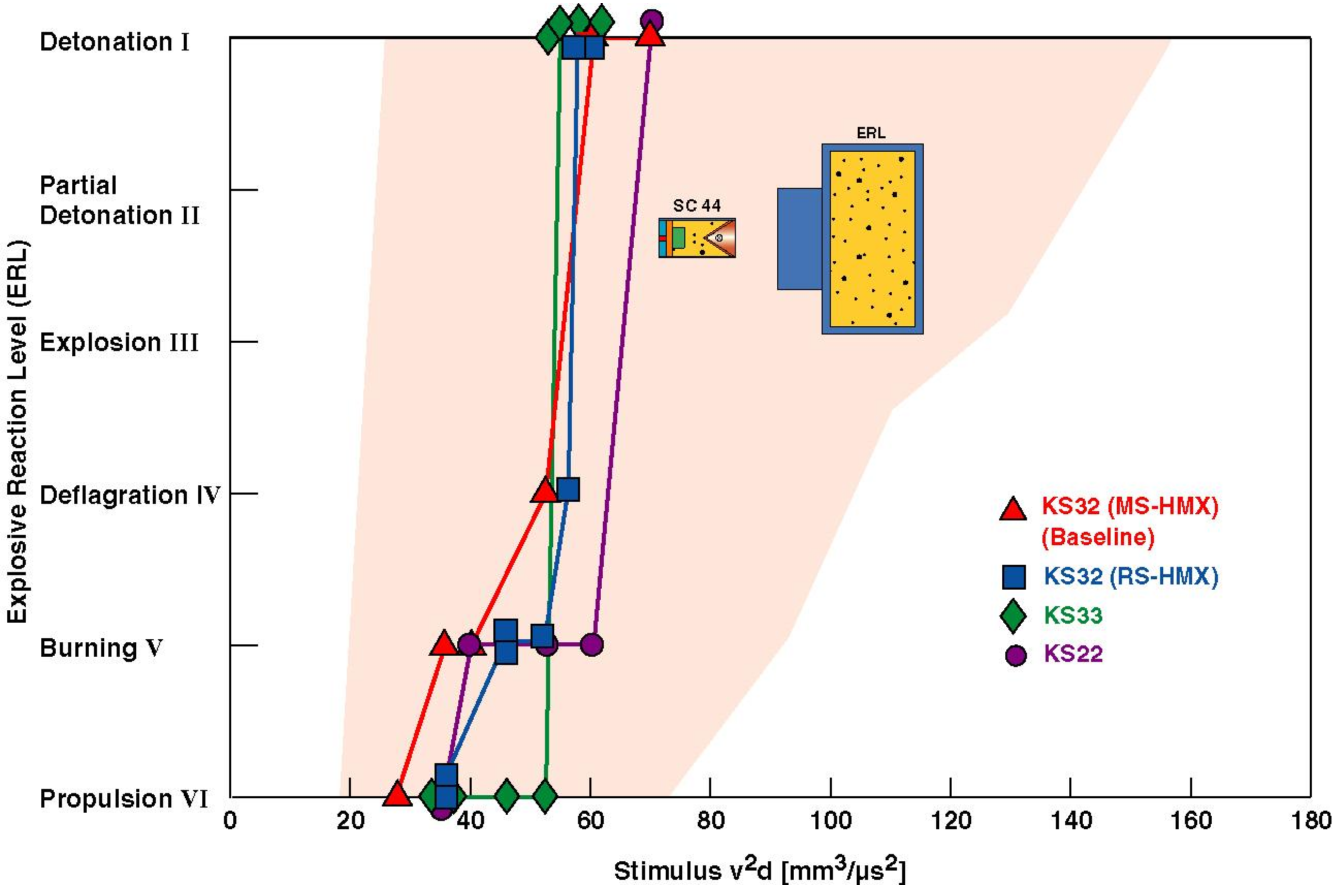
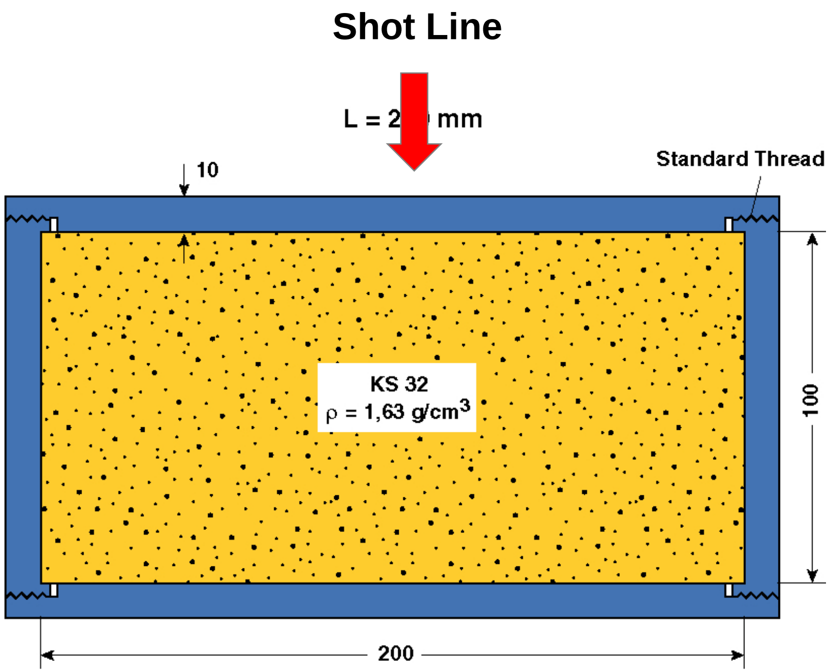
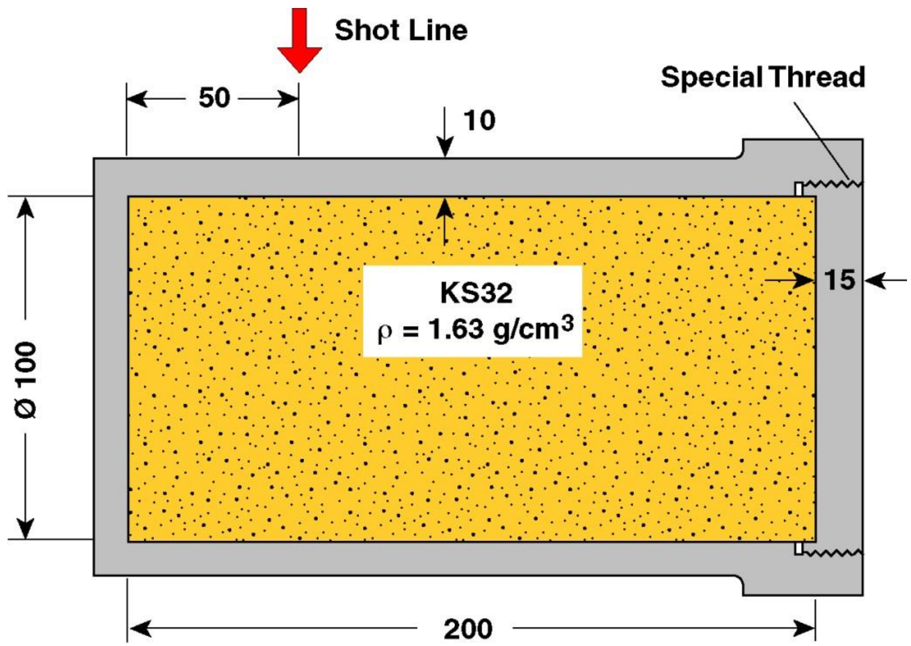
Results: High Explosive Type



- Sensitivity ranking is comparable to ranking with gap test
- KS32 (HMX/PB 85/1%): RS-HMX is less sensitive than MS-HMX – but slope is steeper
- KS33 (HMX/PB 90/10): shows go / no-go behavior
- KS22 (RDX/Al/PB 67/18/15): plateau in ERL-curve @ ERL = V

Confinement Strength

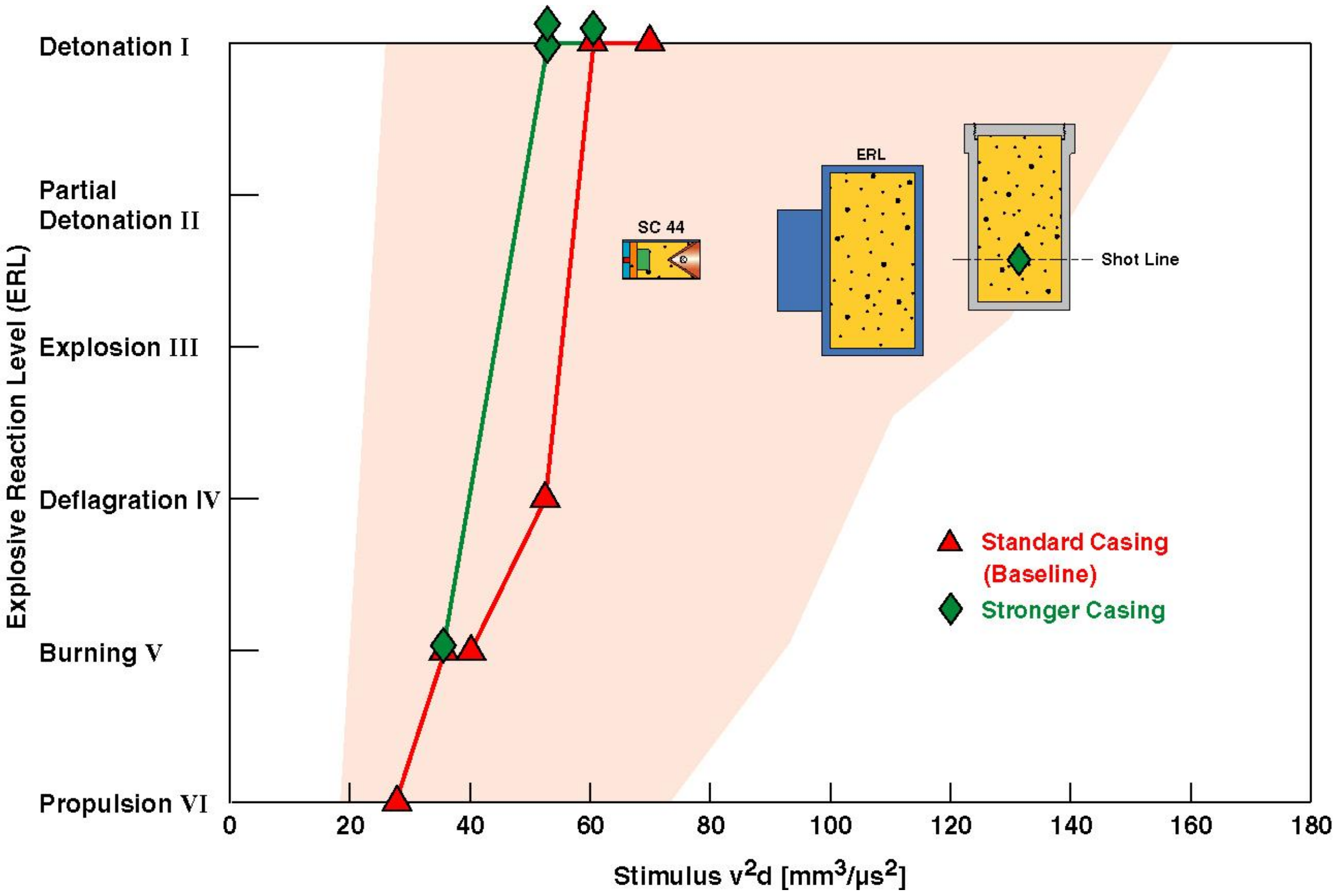




t = 10 mm Mild Steel
Standard Charge

t = 10 mm CrNiMo Steel
Special Thread

Results: Confinement Strength



- **Comparable trend in sensitivity as with 20 mm thick mild steel casing**

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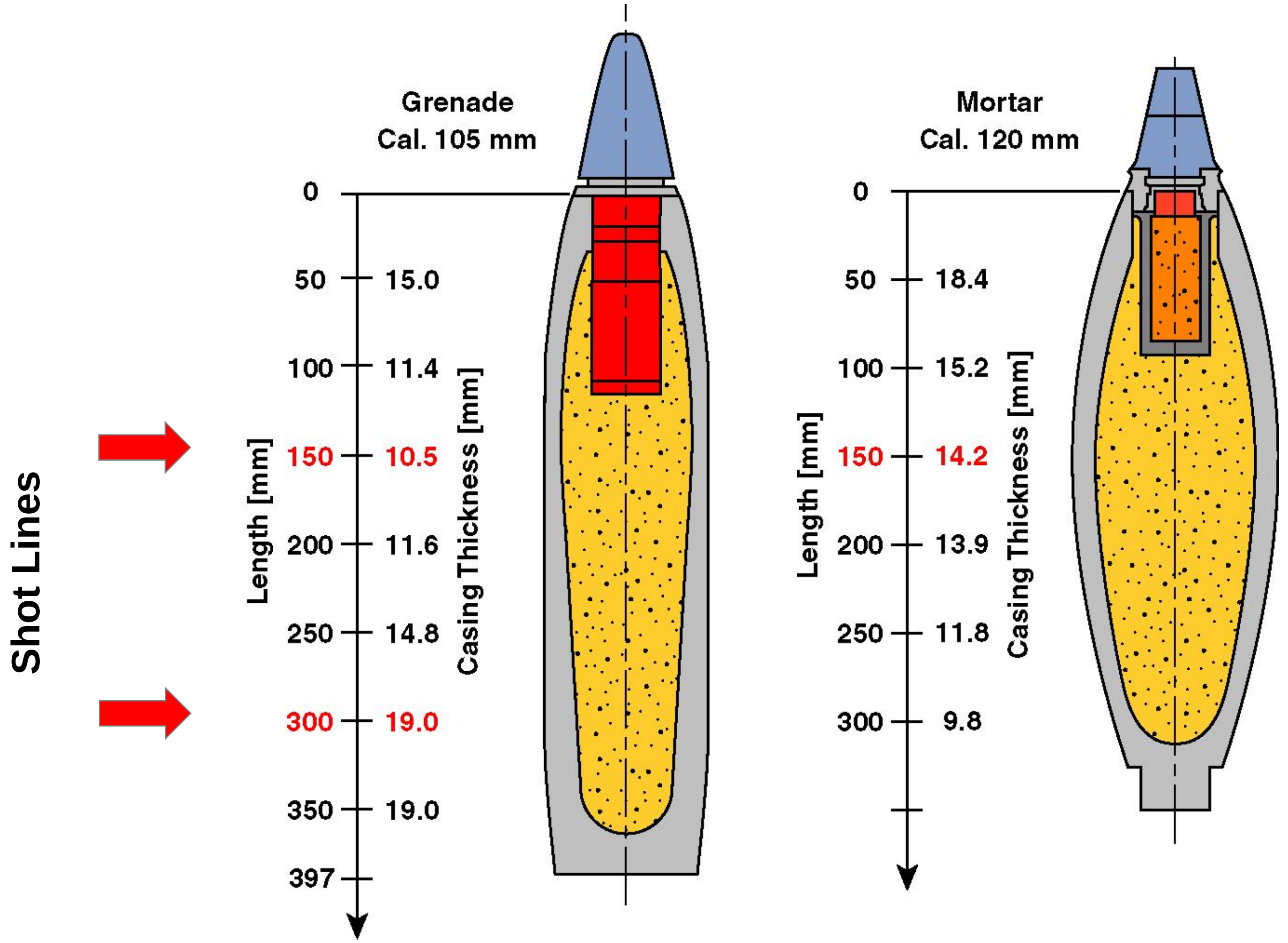
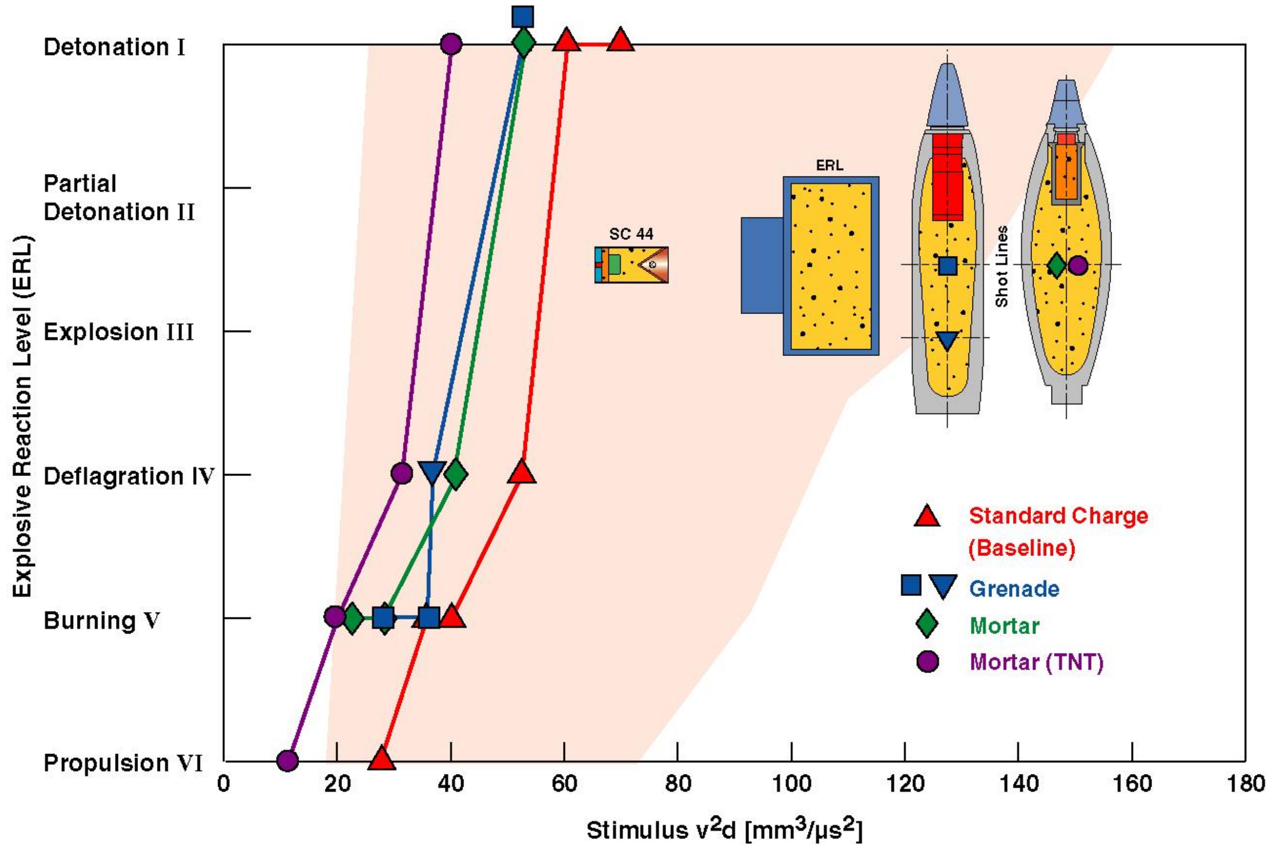
Real Munition: Grenade & Mortar



Mortar also with TNT

Results: Grenade & Mortar



Grenade

- **Same trend as with standard charge with thick (20 mm) mild steel casing or with 10 mm high strength (CrNiMo) steel casing: stronger confinement leads to larger sensitivity**

Mortar

- **Same trend as with grenade**
- **TNT-filled mortar is more sensitive**

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Summary

- **Standard charge represents real munitions (e.g. grenades, mortars) very well**

- **Confinement (e.g. casing thickness, strength, weak spots) is very important for sensitivity behavior**

- **Almost trivial: insensitive HE filling makes munition also less sensitive, but „special bahavior“ is possible**

- **Sensitivity variation due to munition parameter variation is 2 - 3 times larger than slope in ERL-curves**

- **That means: additional information is necessary for the *low order disposal* of EOD / IED-charges**

Thank You for Your Attention !

Questions ?

POC:
Dr. Werner Arnold
Warhead Systems & Lethality
Phone: +49 8252 99 6267
Email: werner.arnold@mbda-systems.de

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