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Recommendations For Shaped Charge Jet, Munitions Test Procedure

Part 2 : Gun Propellant

Dr Frédéric PEUGEOT, March 2003

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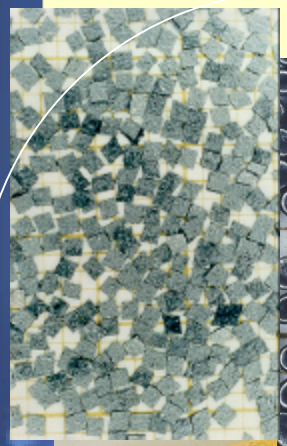
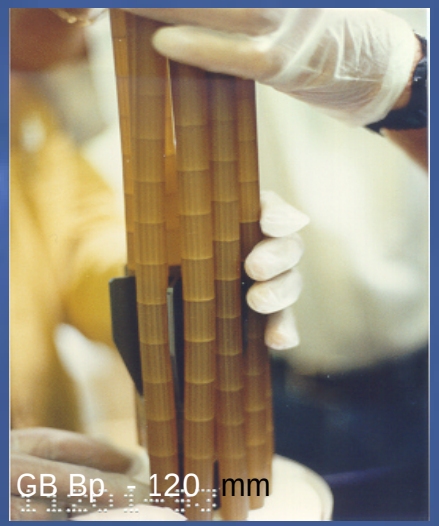
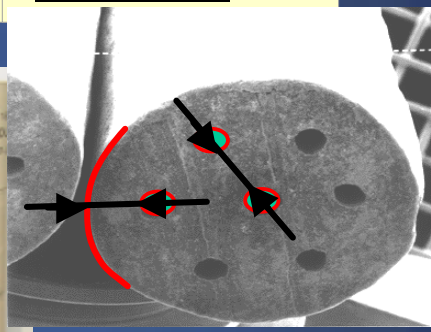
Introduction
Influencing factors

Shaped Charge Jet	Propellant Ballistics Properties	Propellant Physical Properties	Propellant Shock Sensitivity	Propellant Configuration
Velocity Diameter Composition	Impetus Burn rate Ignition Temperature	Composition Particle sizes Bed loading density % TMD (voidage) Homogeneity Glass transition temp. Binder/Filler interaction	CJ parameters Hugoniot Critical energy Critical Diameter	Shape Perforations (number, size,…) Web Size Outer diameter Mass Confinement







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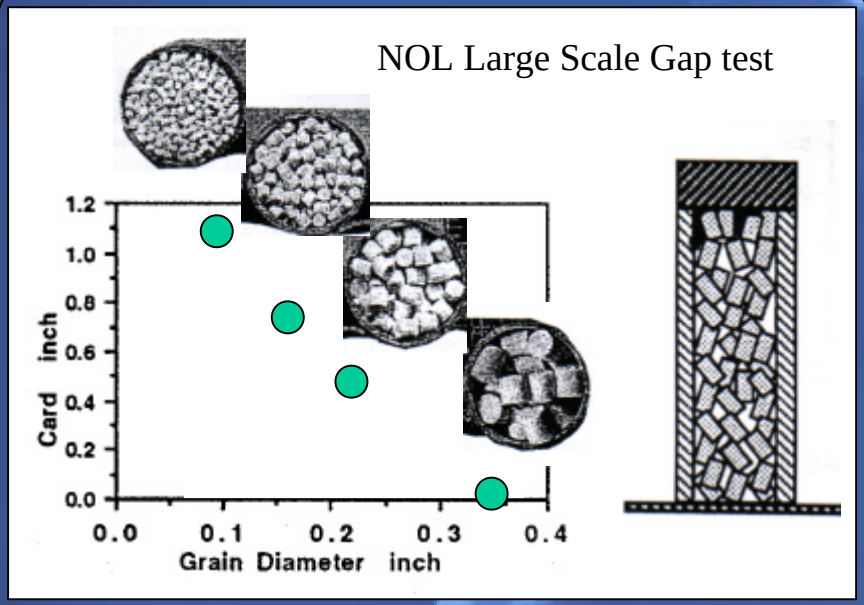
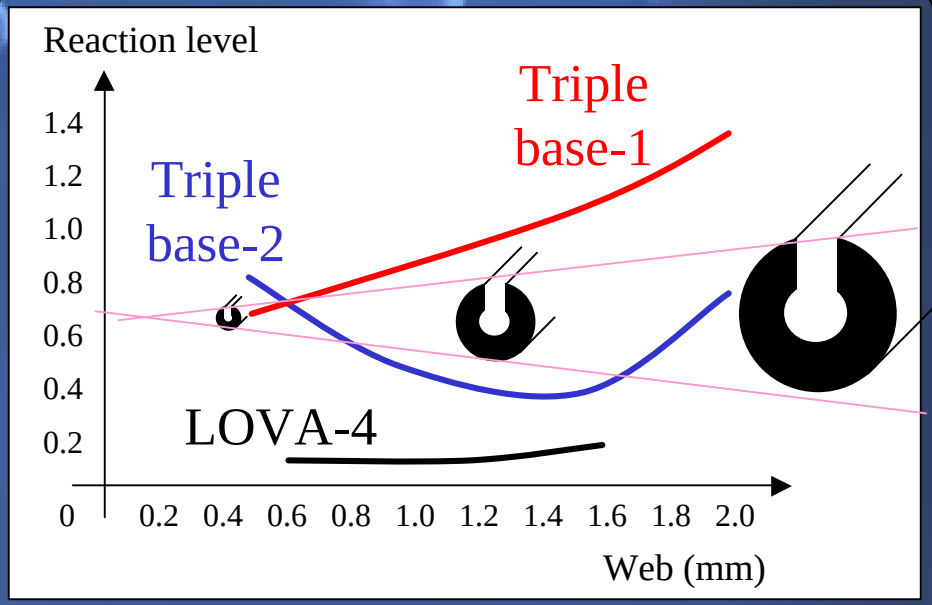
Shortcomings

Scaling effects



The greater,
the less shock sensitive



The thicker,
the more shock sensitive

U shape?

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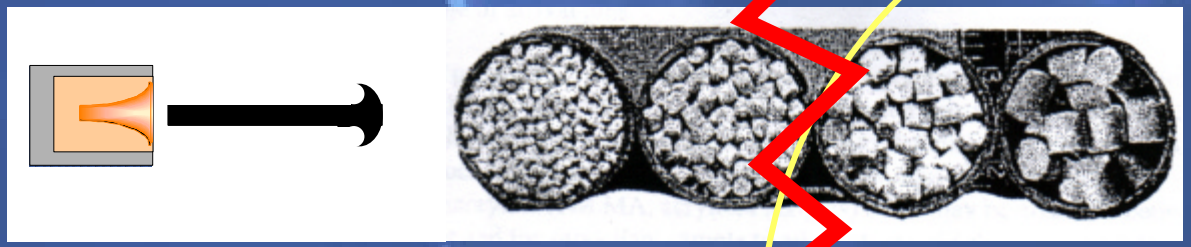
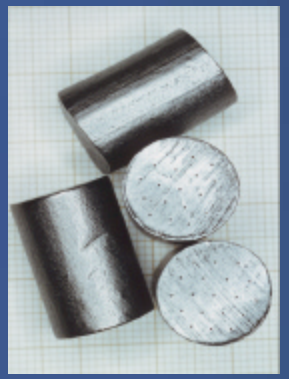
Resolving Shortcomings

Scaling effects



Actual Size

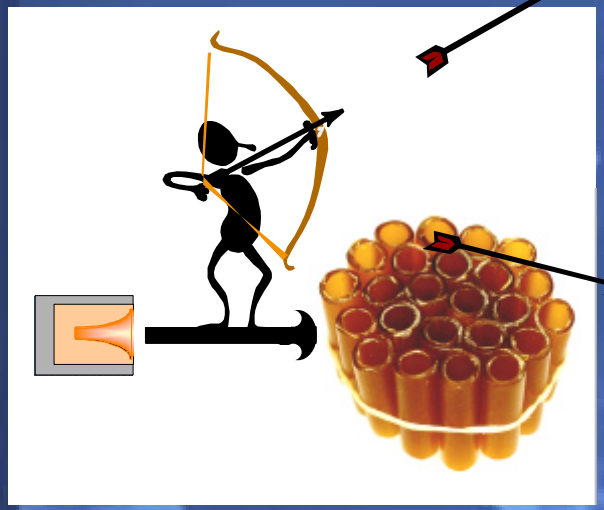


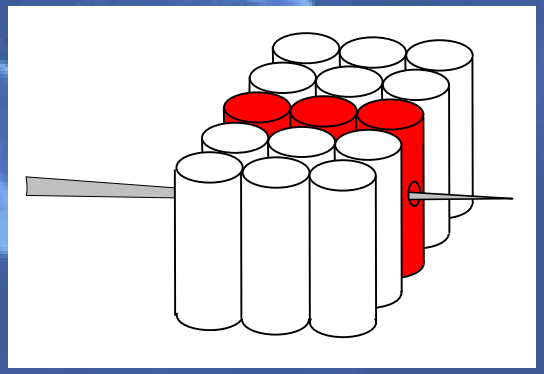
The response is driven by the bed properties

The response is driven by the grains properties

Reaction Mechanisms (1/2)

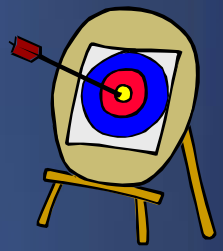
Macroscale





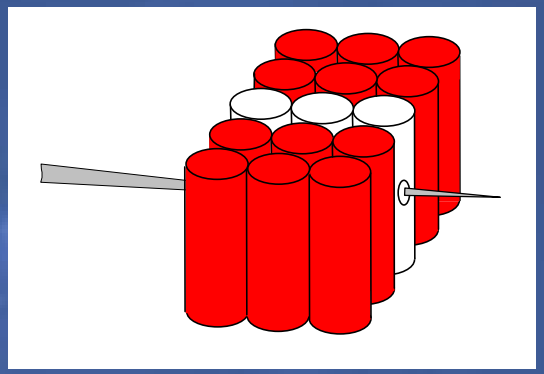
AREA 1

Jet tip / Grains interaction



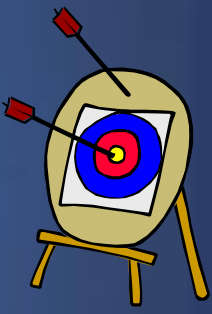
Mechanism:

Shock Detonation Transition



AREA 2

Grains / Grains interaction



Mechanism: ?

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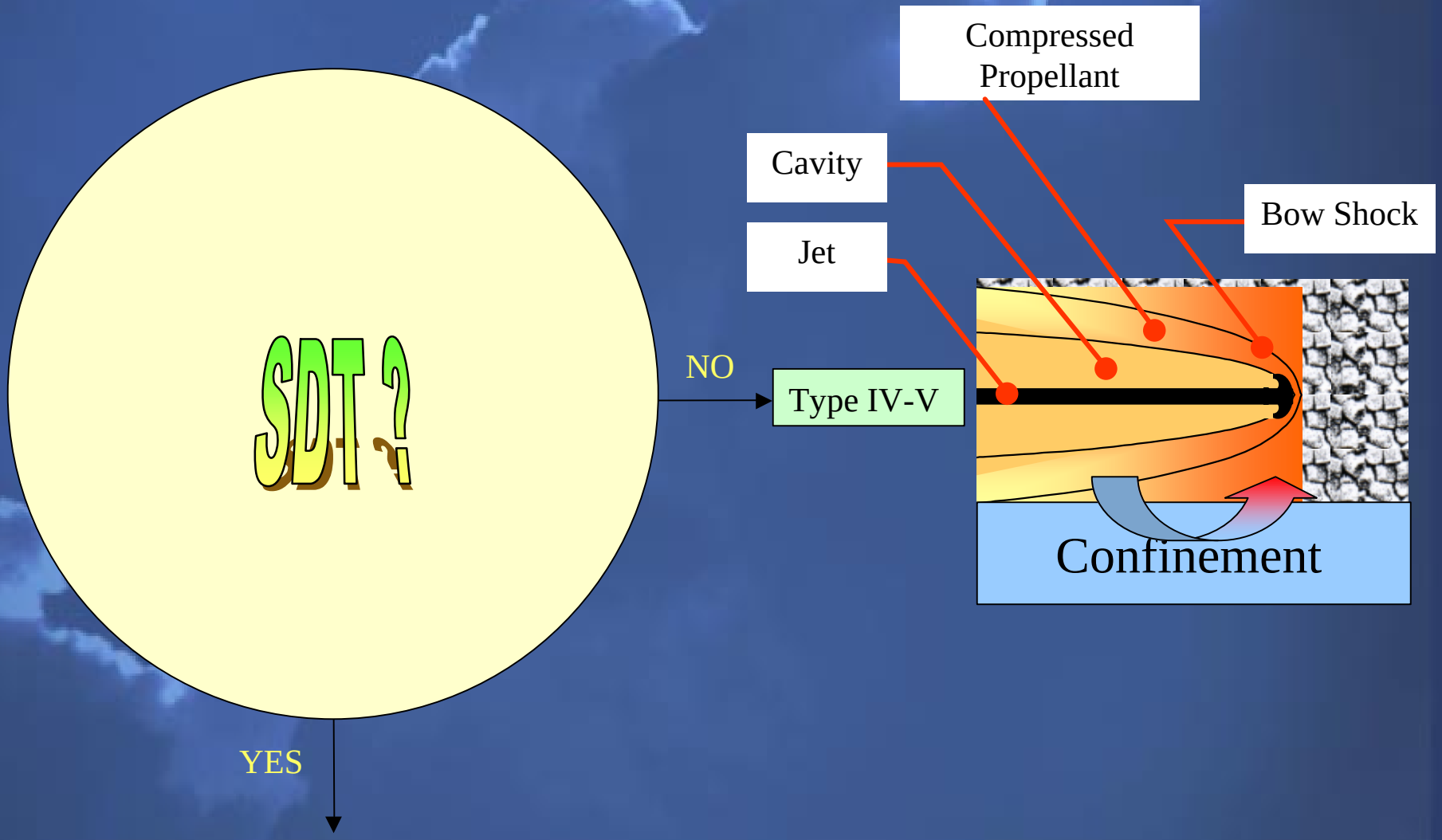
Area 1 Protocol
Interaction Jet-Grain(s)



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Area 1 Protocol
Interaction Jet-Grain(s)

Energy provided
by the jet impact
>
Formulation Critical energy ?

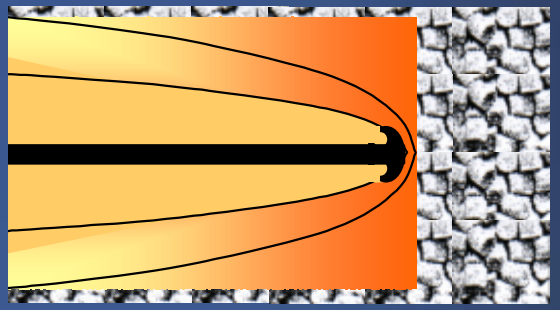
YES

Grains dimensions
>
Grains critical dimensions ?

YES

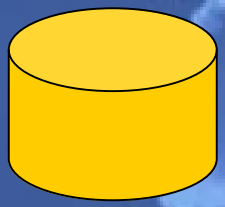
NO

Type IV-V

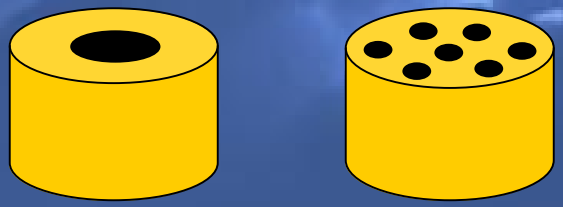


Shortcomings
Critical diameters

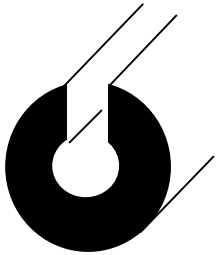
Formulation



Grains



What is the influence of a perforation or several perforations on the critical diameter?



Formulation	Formulation Critical Diameter (mm)	Slotted Tube Critical Web (mm)	Slotted Tube Critical Outer Diameter (mm)
A	2.9-4.1	1.7-2.0	4.5-5.3
B	3.8-4.7	2.5-3.2	8.3-10.7
C	2.7-3.8	2.1-2.5	7-8.3

But, Debenham obtained a high order response even with a web lower than the critical web….

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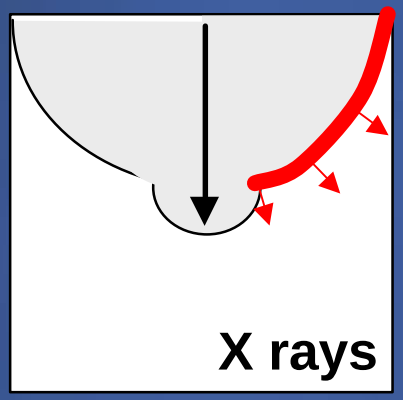
Reaction Mechanisms (2/2)

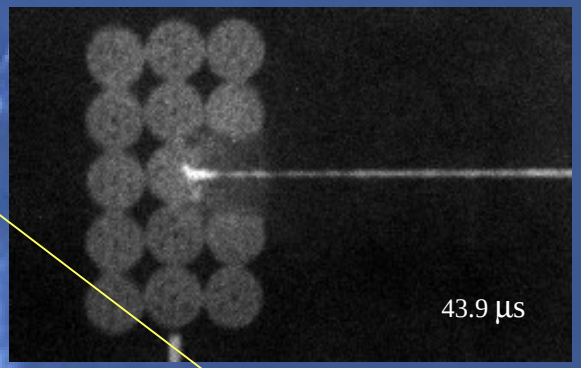
Area 2 - Macroscale



WATSON (1992)

Layers transmission

X rays



Sympathetic detonation

PEUGEOT (1996)

ZIMMERMANN (1996)

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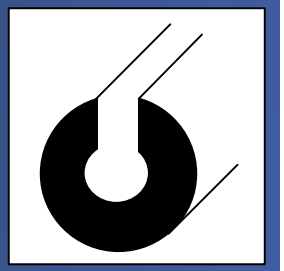
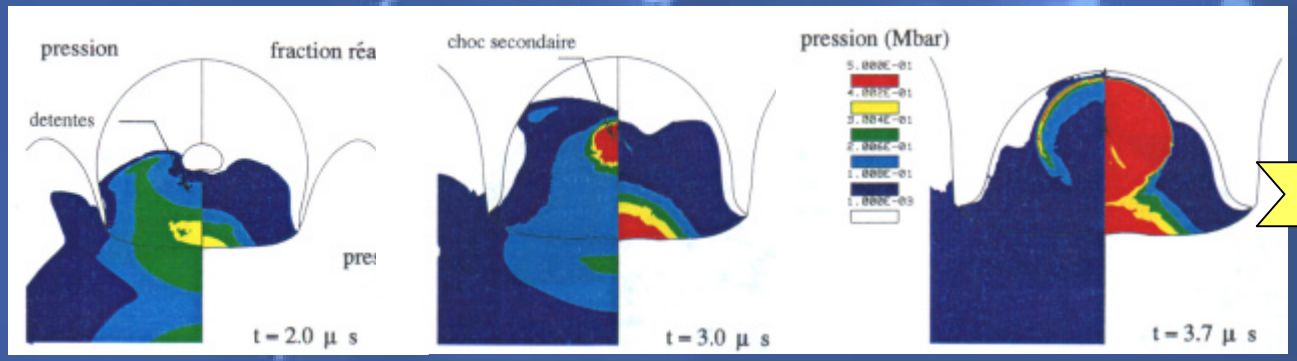
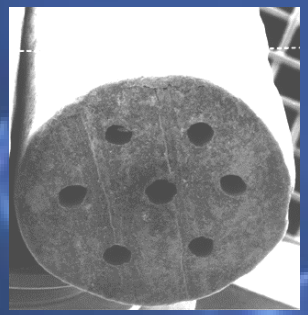
Sympathetic Detonation

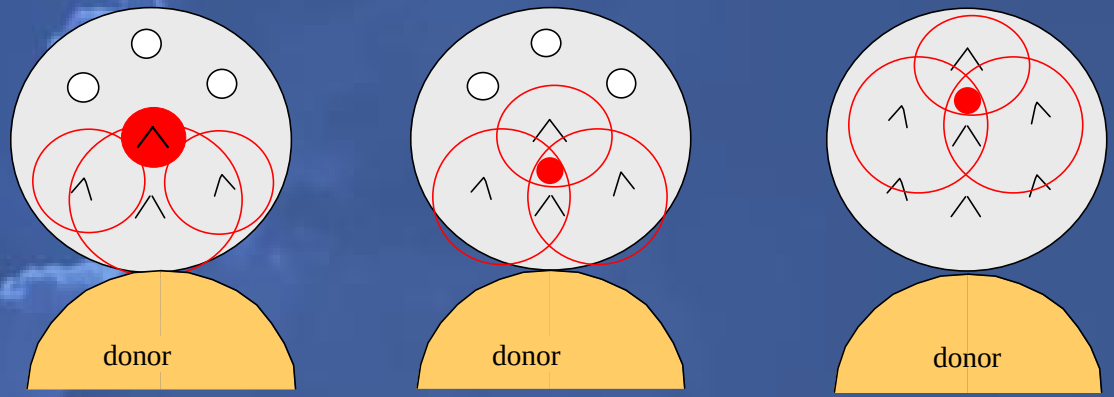
Area 2 - Mesoscale Mechanisms





IDT





IDT

XDT I

XDT II

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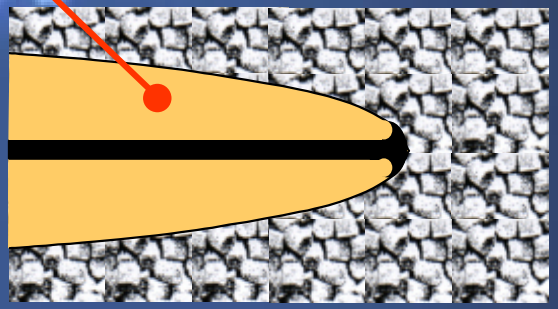
Area 2 Protocol
Interaction Grain(s)-Grain(s)

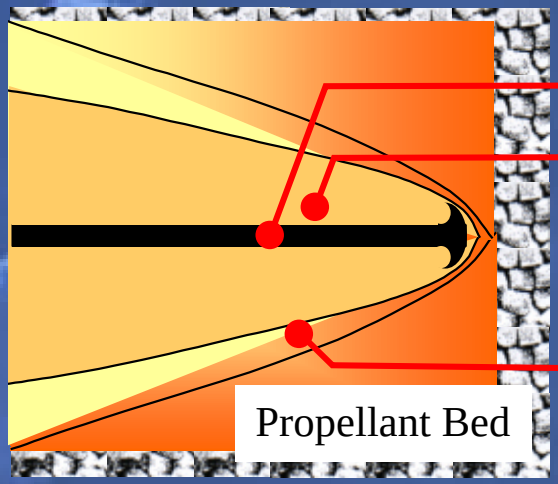
Bow Shock +Cavity

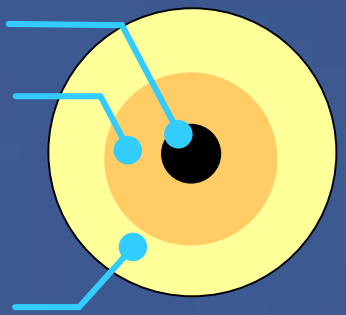
Sympathetic Detonation of the grains?

NO → Type II-III

YES → Type I







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Conclusions

Testing Recommendations

Test conditions

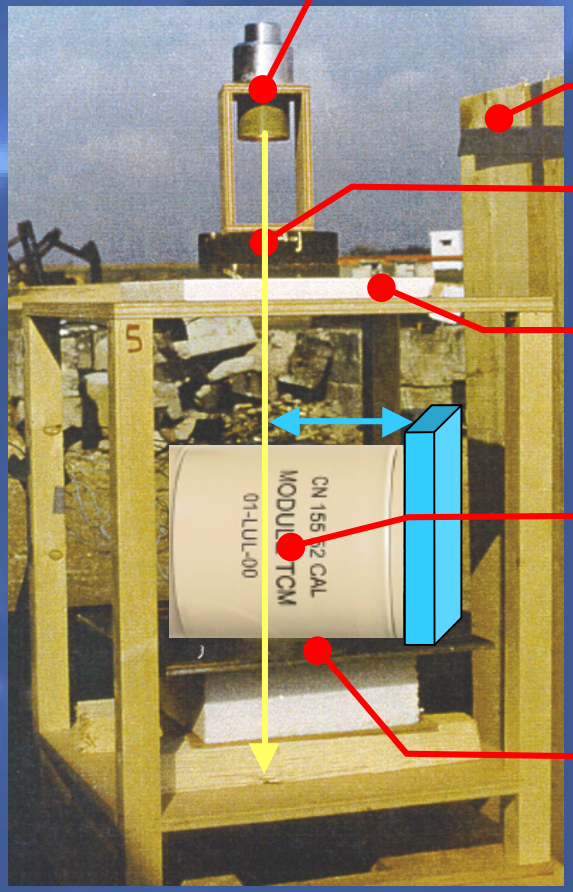
No jet particulation
No inverted gradient effect
No spall
Longest credible path

Test configuration

Represent the life cycle configuration

Test instrumentation

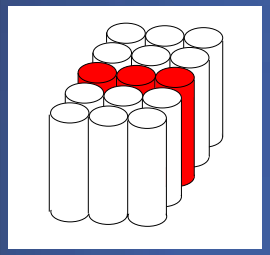
Threat & Reaction level



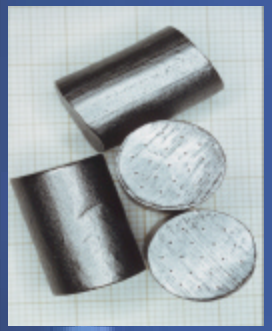
Stand off
X-Ray
Min attenuator thickness
Stripper plate
Representative casing
Representative shielding
Representative dimensions
Sufficient amount of prop.
No additional Confinement
Witness plate

Conclusions

The best LOVA propellant

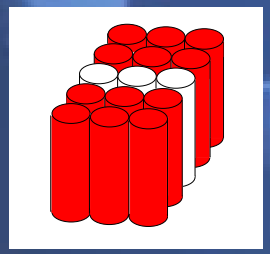


- ✓ The lowest Hugoniot
- ✓ The highest pressure dependent critical energy curve
- ✓ The highest critical diameter

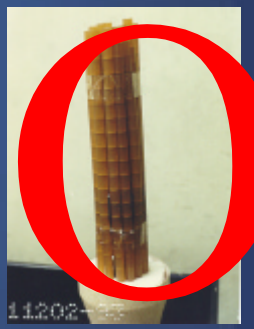


Gun propellant vulnerability to SCJI is driven by 2 mechanisms:

- the sensitivity to shock of the gun propellant
- the mechanical behavior of the gun propellant



- ✓ Dimensional characteristics that reduce the risk of Sympathetic Detonation
- ✓ The best mechanical properties (XDT issues)
- ✓ The lowest bed loading density (opposite to ballistics properties) not to favour SD



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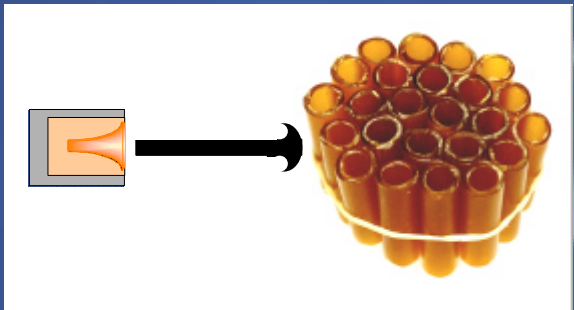

Any Questions?

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