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Title: A review of fragment impact test capability sponsored under the DoD/DOE Joint Munitions Program

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Fragment Impact Gun Testing Technology Coordination Meeting
Naval Postgraduate School
August 7, 2014



A review of fragment impact test capability sponsored under the DoD/DOE Joint Munitions Program

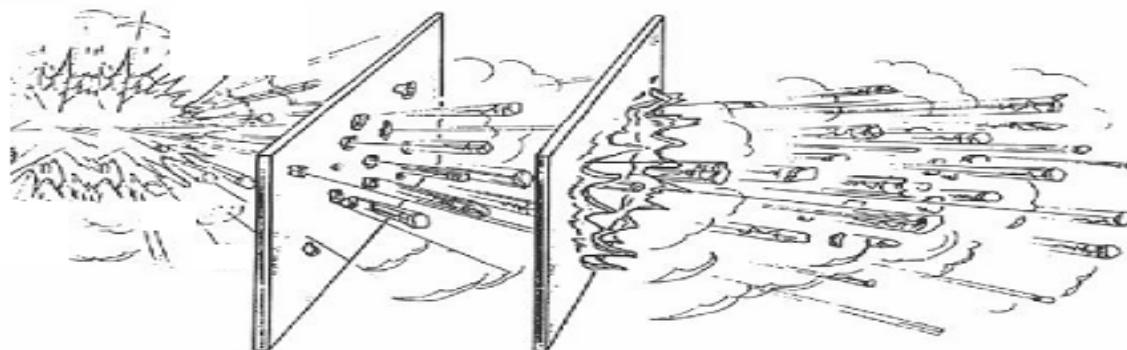
August 7, 2014

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Ballistic insult is a long standing problem

Fragment and Bullet Impact

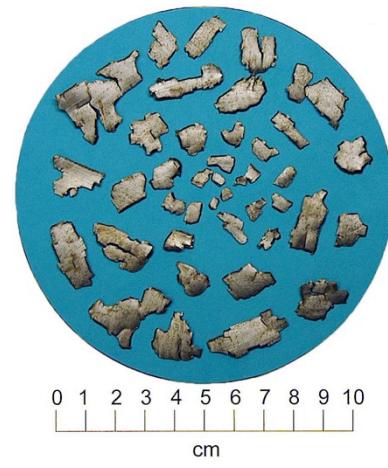
Fratricide – Sympathetic Reaction



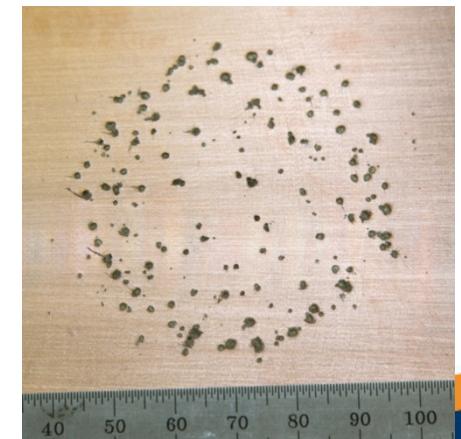
Massive fragments



'Cornflakes'



Very small fragments



Ballistic insult test sources at LANL

- Small arms collection – up to 0.50 BMG
- 0.50 caliber powder guns
- 0.50 BMG & 20MM cannon tubes w/snap caps
- Universal Receiver w/0.308, 0.50 BMG & 14.5MM
- 30MM cannon with 40MM L/70 breach
- 60MM cannon with custom breach

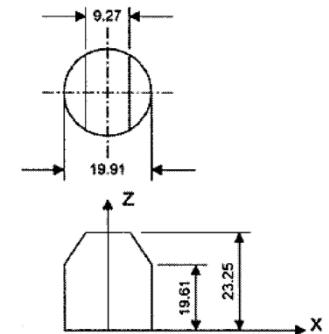
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'Disposable' 0.50 gun & test set-up



Fragment
Simulating Projectile
(FSP)



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30mm tube / 40mm breach launch system at TA-36 Site 12– upper mound



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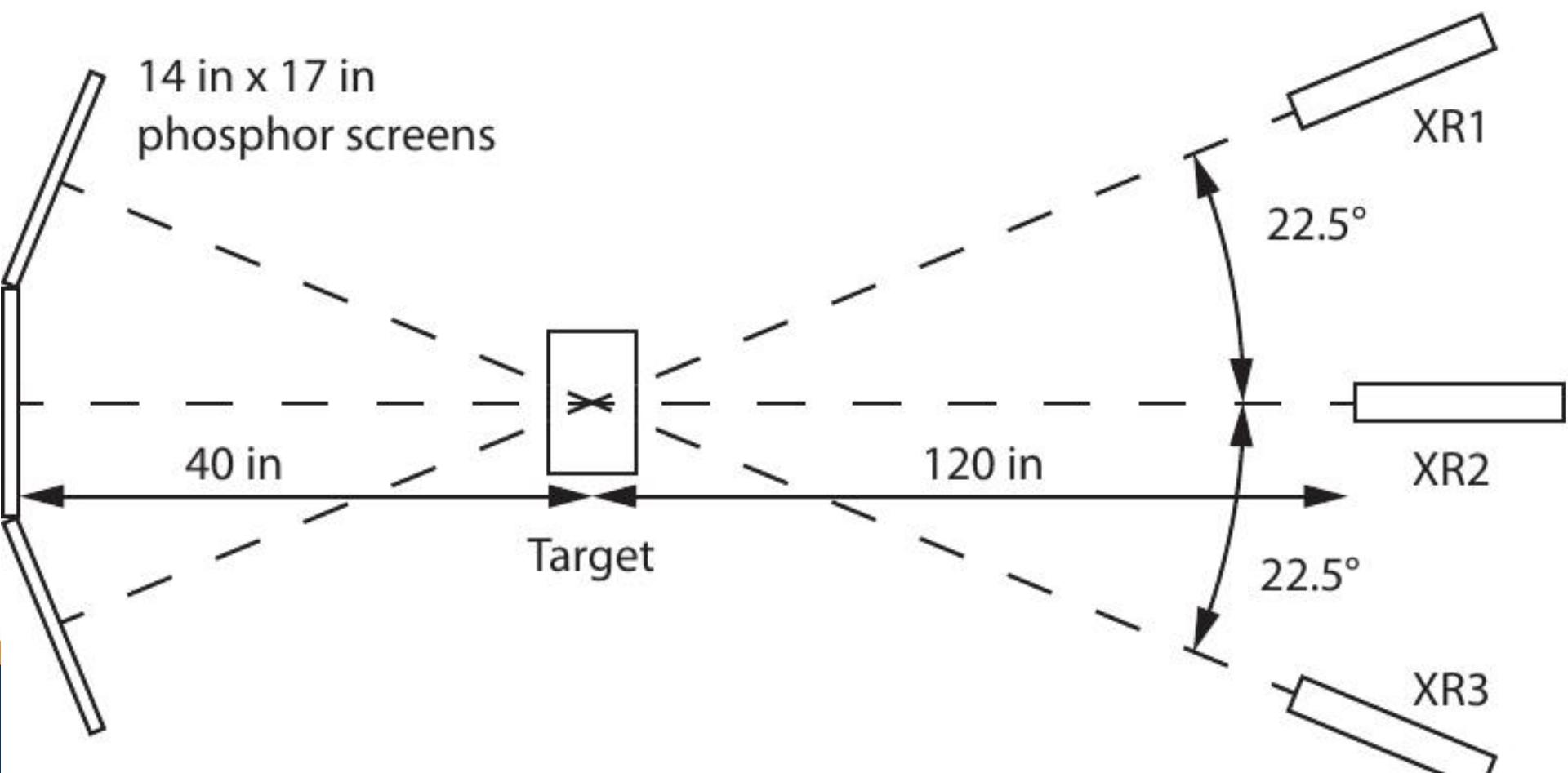
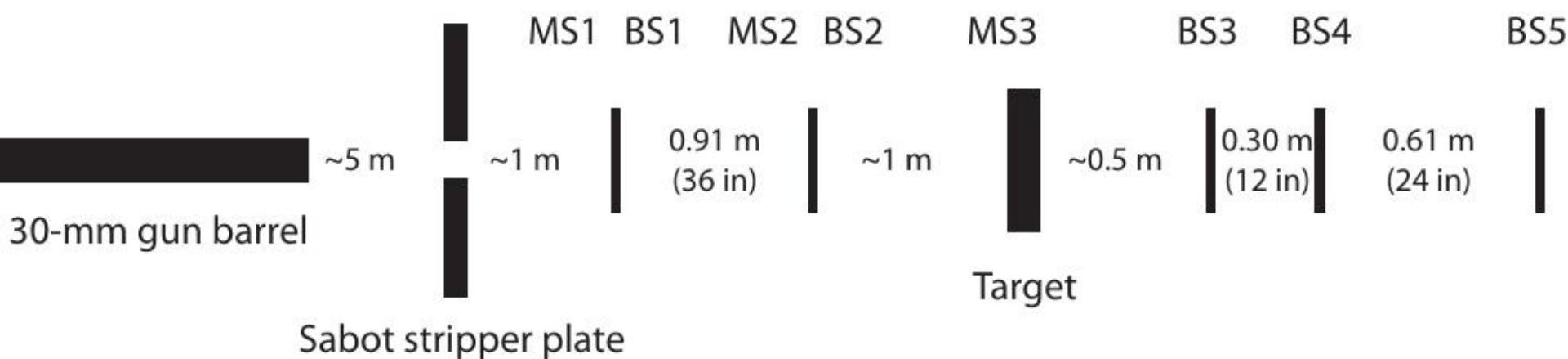
60mm tube launch system at TA-36 Site 12–upper mound



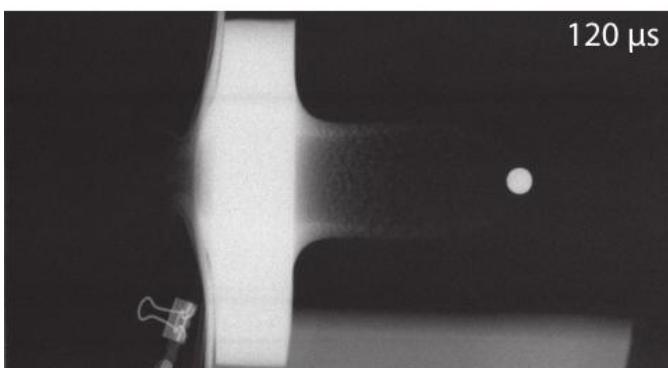
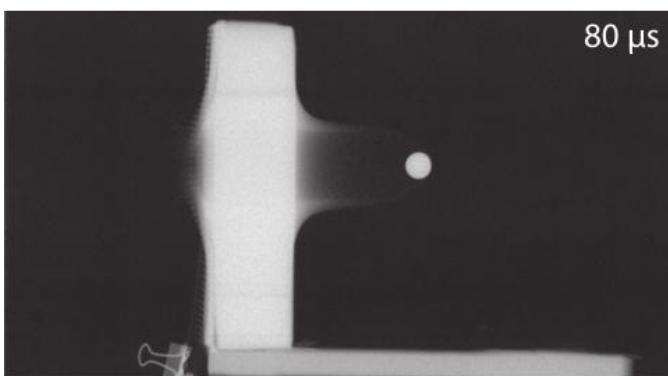
Using universal tracked chassis from M110 self-propelled howitzer

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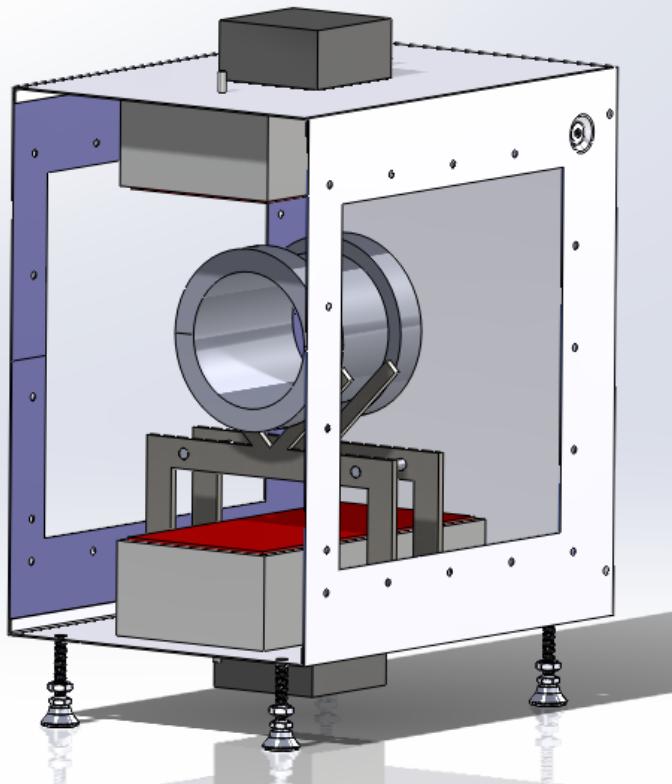
1620 m/s



(a)

(b)

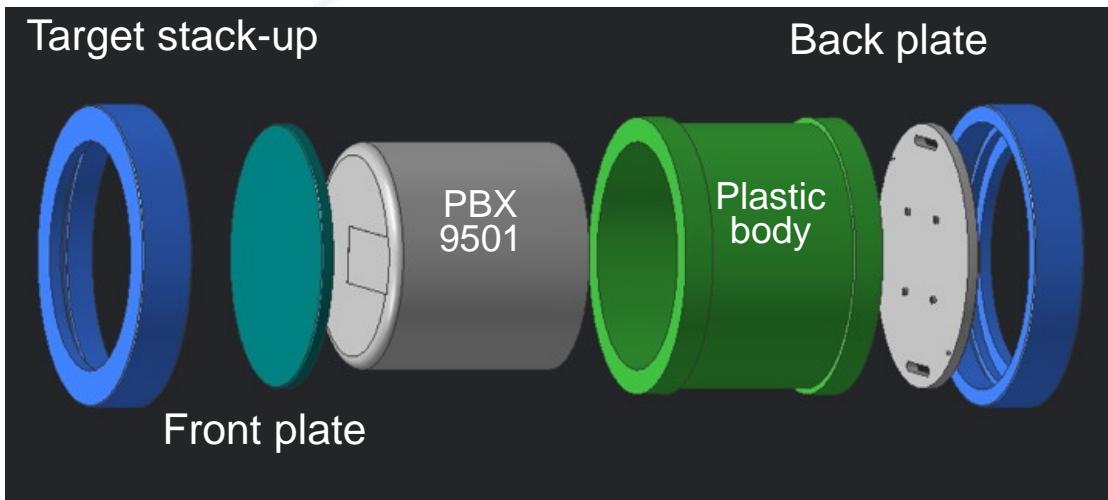
New capability to heat target to 250C



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Ball impacts on PBX 9501-filled targets



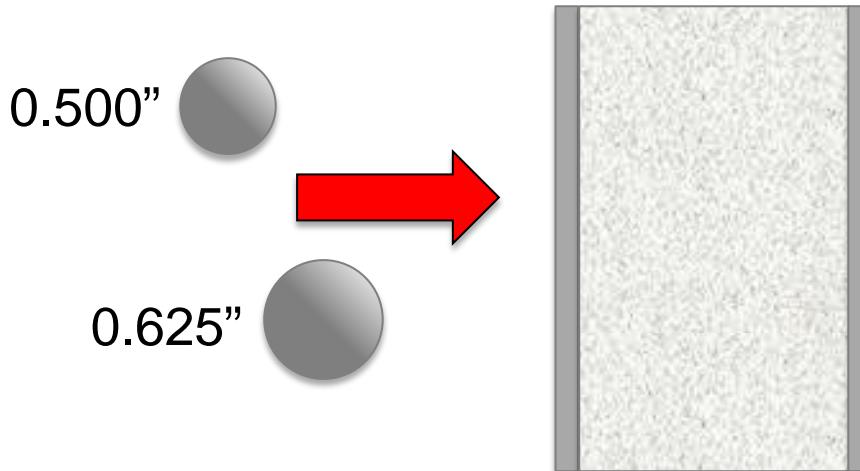
Modified sabots for optimum velocity and separation

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Example: Ball impacts on covered PBX 9501 targets

Cylindrical PBX 9501 charge
1018 steel cover plate
Plastic can design from SMIS shots



Diagnostics

Four PZT pins on cover
Velocity – make/break
Single 1 MeV X-ray
3 PZT rails w/7 pins

But we could have also used PDV and microwave interferometry

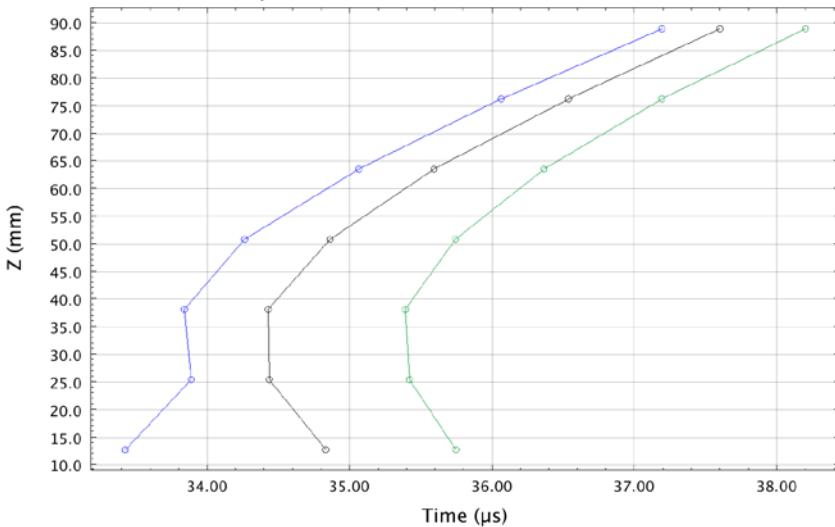
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0.625 ball impact experiments

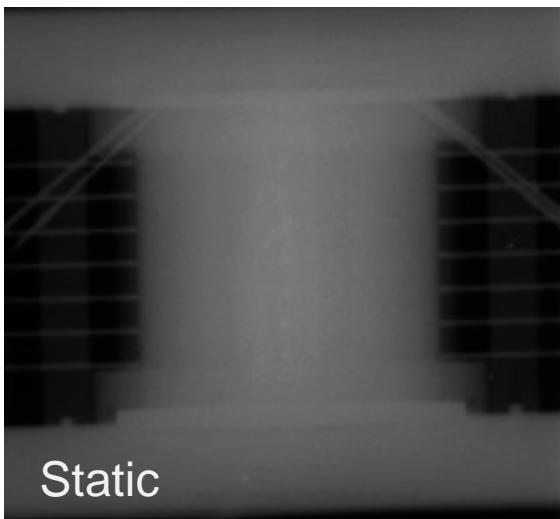
Covered PBX 9501, 0.125 inch 1018 Steel Plates

5/8" Detonation at PZT 2-3

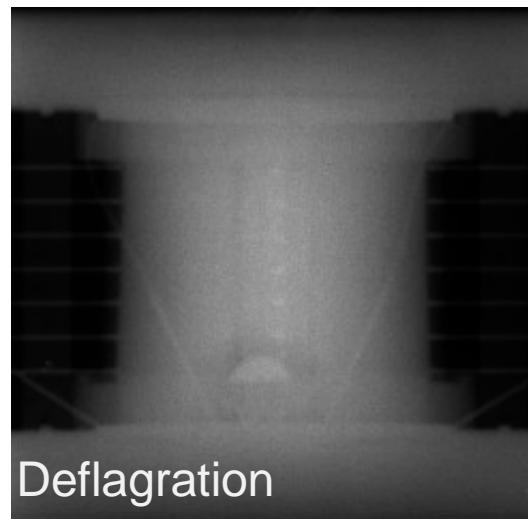


5/8" ball

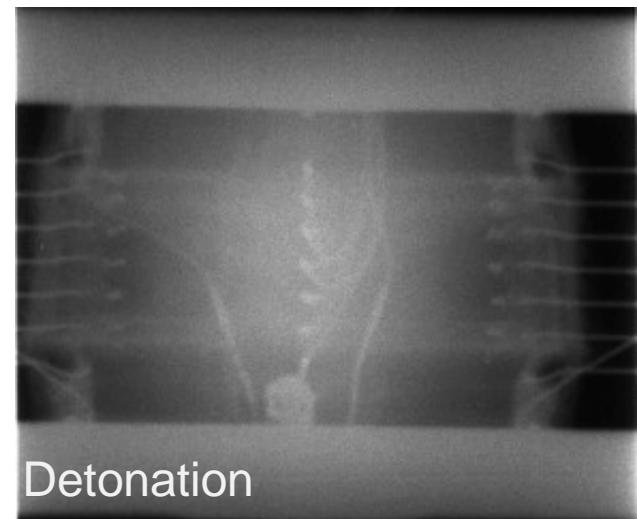
Charge (g)	Speed (km/s)	+/- (m/s)	Go/No-Go
190	1.669	1.5	N/A
190	1.631	∞	Det. at PZT 2-3
180	1.626	0.99	Det. at PZT 5-6
170	1.547	0.5	Deflagration
175	1.509	2.99	Deflagration
180	1.543	0.72	Deflagration



Static



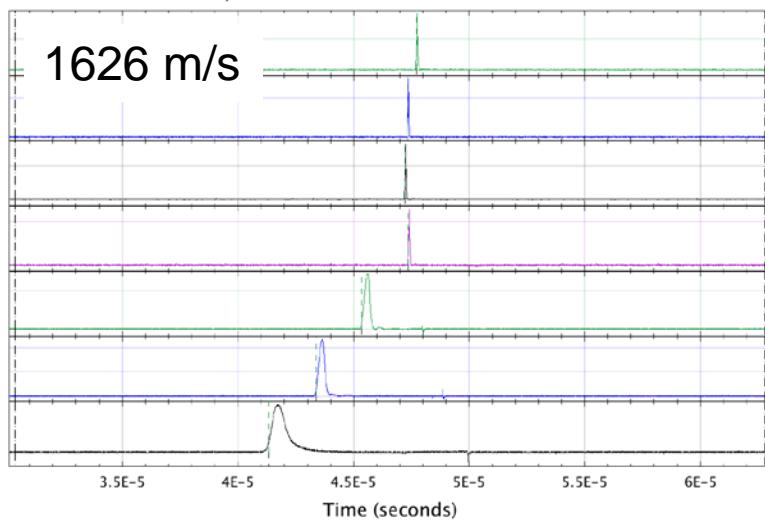
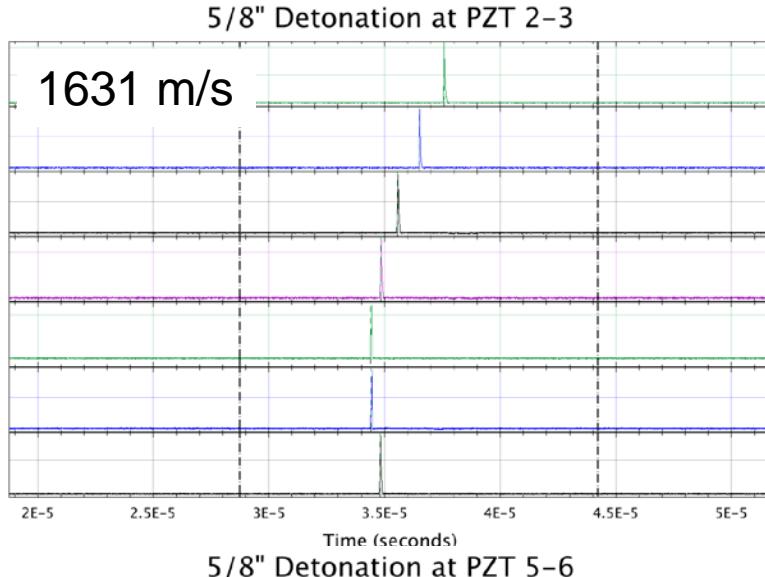
Deflagration



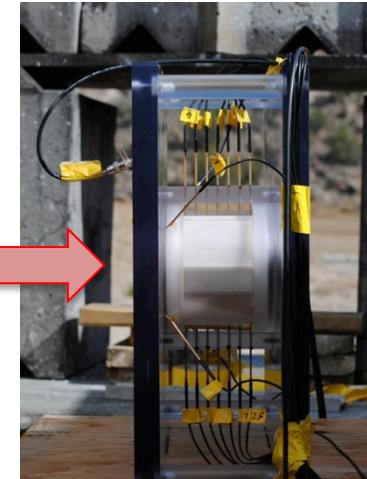
Detonation

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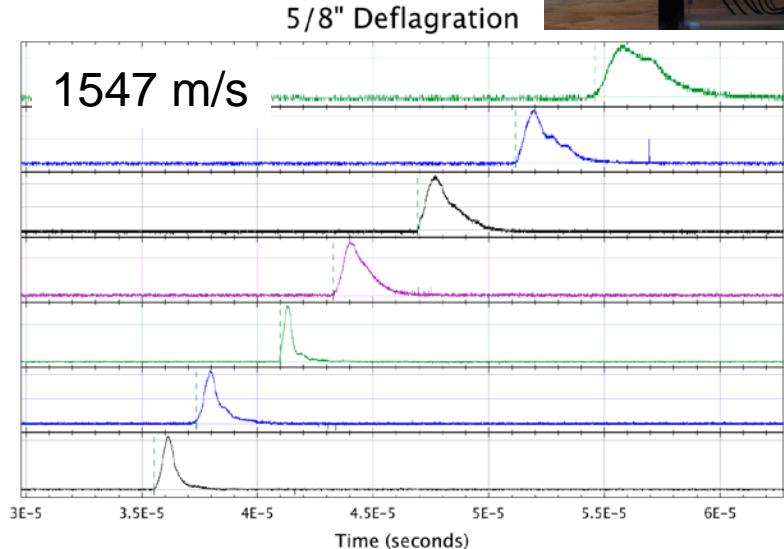
Ball impacts on PBX 9501-filled targets



3 PZT rails w/7 pins

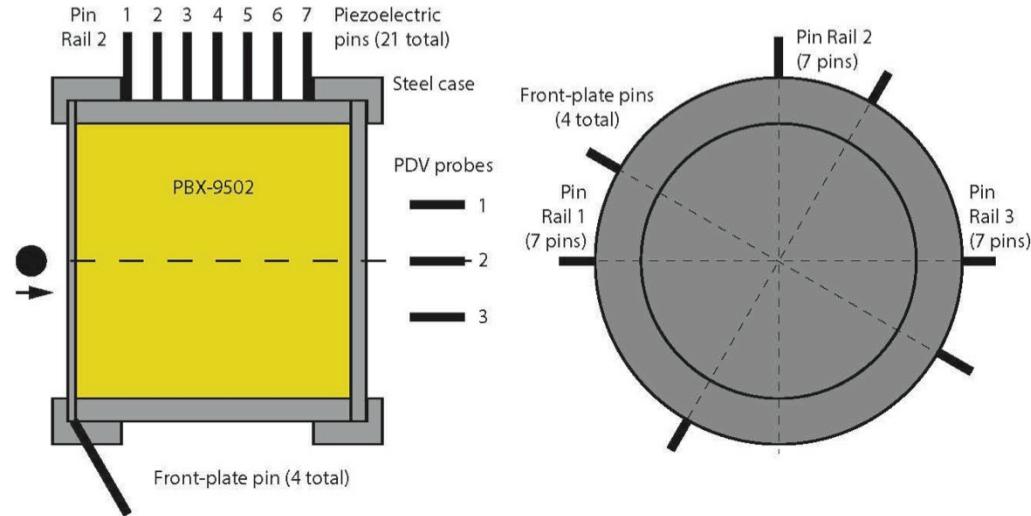


Timing &
'Content' of the event

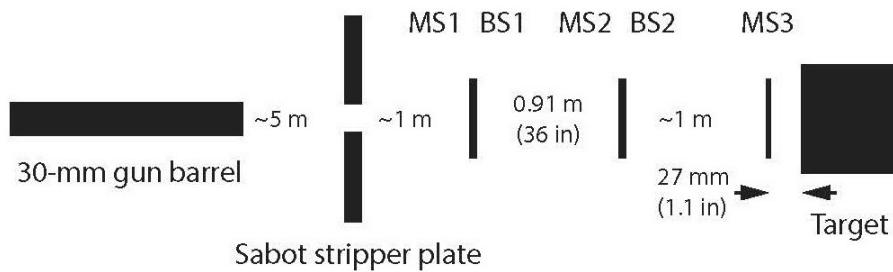


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Make Up of Shot K12-21556 & test set-up

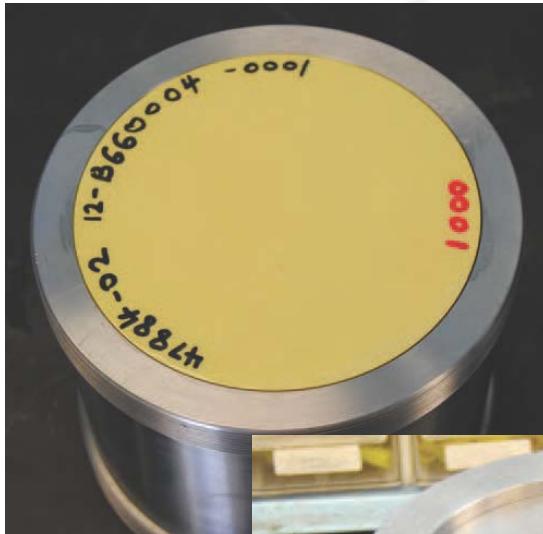


1018 steel case
0.125 / 0.25 1018 steel face plates
Carbon steel ball
 $V = 2.462 \text{ km/s}$

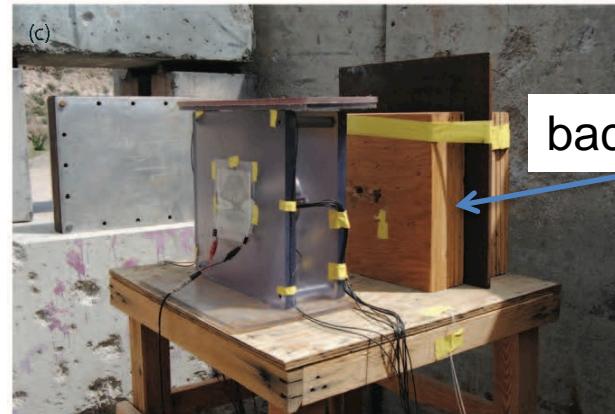


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Views of hardware for Shot K12-21556



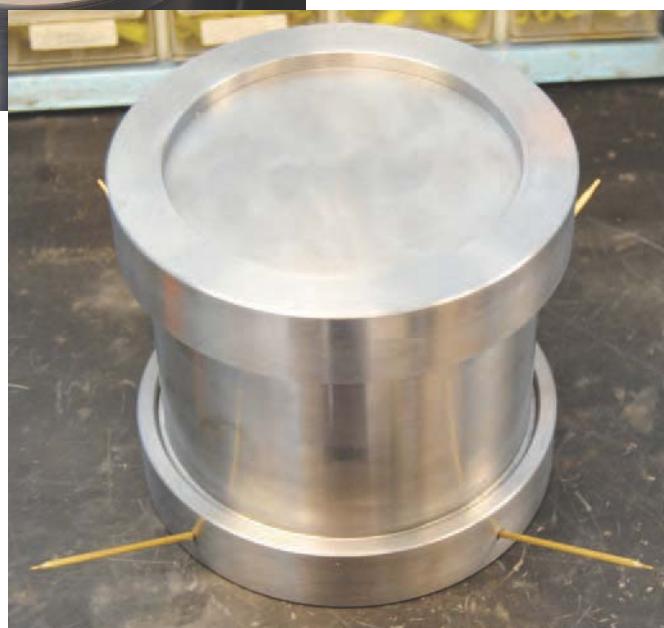
Front face
before cover
was installed



backstop



Assembled
target – view
of rear face

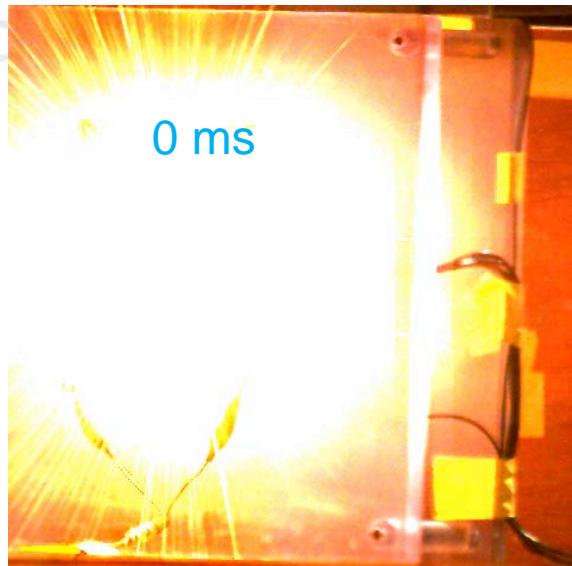
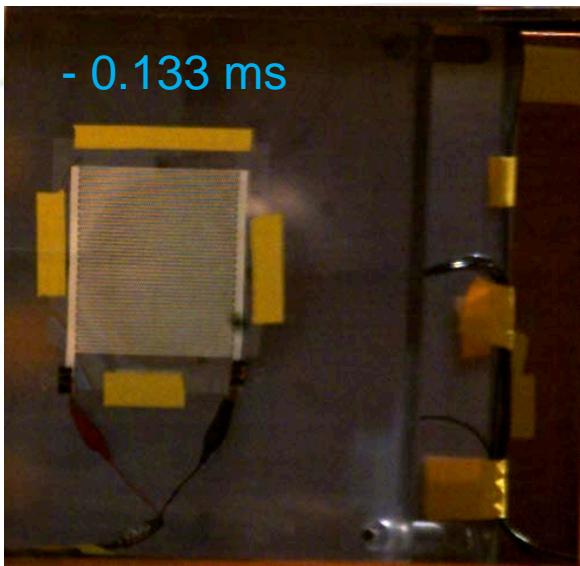


Pins to
triangulate
impact point



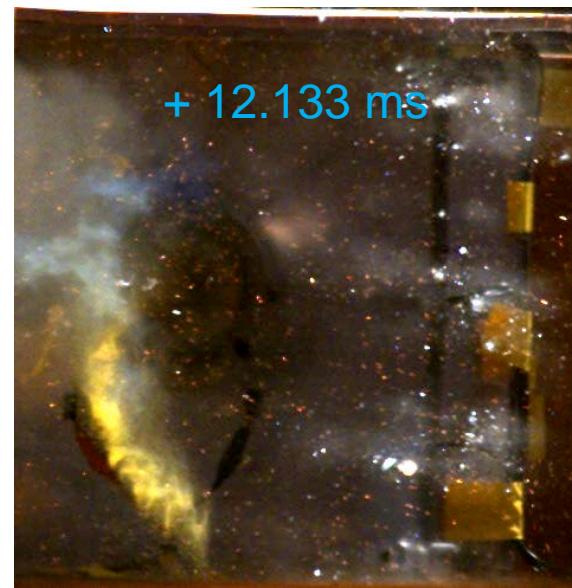
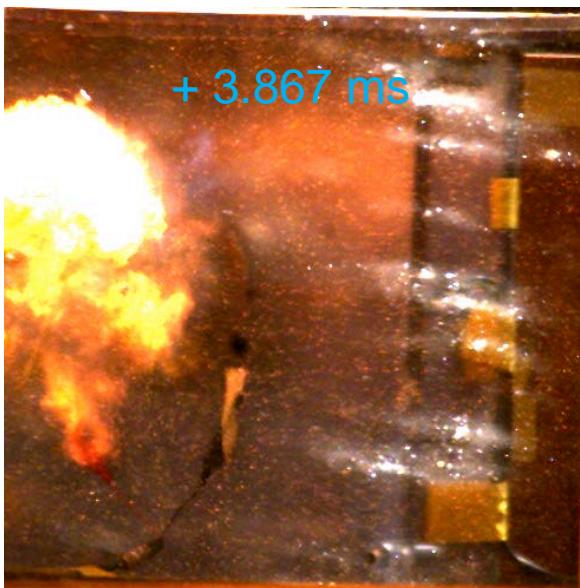
Pin rails

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K12-21556

Bright flash
followed by
~ 4 ms of
combustion.



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PBX 9502 dust
seen
emanating
from entry hole
at 12 ms.

Ball did not
emerge from
assembly.

Recovered target from Shot K12-21556

Significant deformation of the 1018 face plate



Damaged PBX 9502 fill



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Recovered bits from Shot K12-21556



Remnant of the low carbon steel fragment



Smaller steel pieces recovered
– mixed cover plate and ball materials

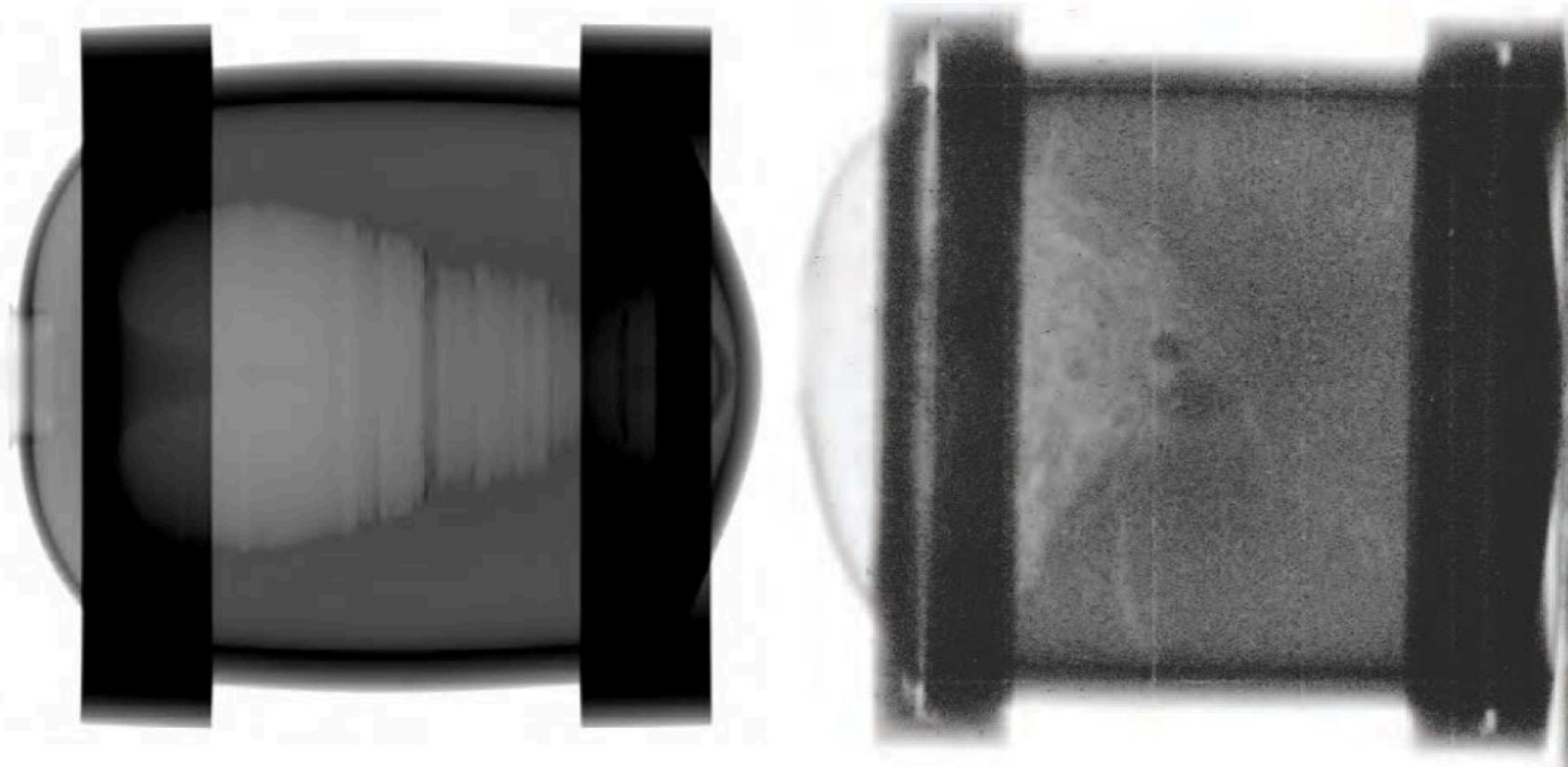


PBX 9502 pieces recovered
– largest is about 3 cm wide

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Comparison of CTH simulation with static X-ray from K12-21556

No advanced strength or damage model for the PBX 9502, steel not correct, ...



...but not bad for a first look.

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