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

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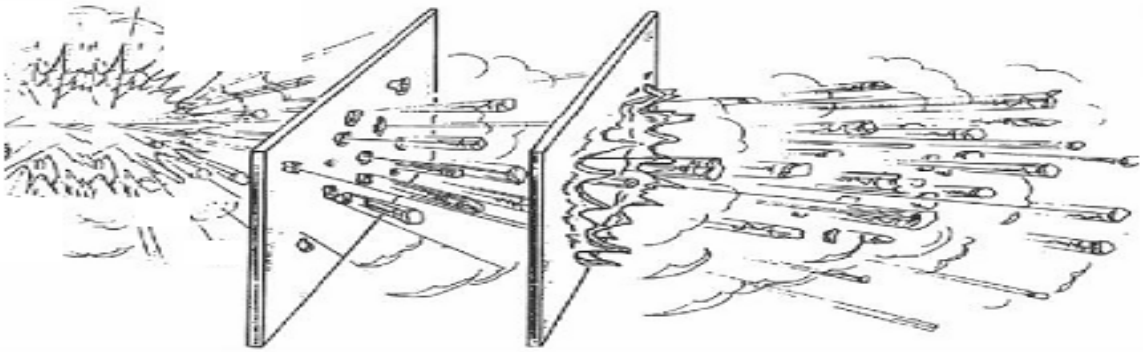
A review of fragment impact test capability sponsored under the DoD/DOE Joint Munitions Program

August 7, 2014

Ballistic insult is a long standing problem

Fragment and Bullet Impact

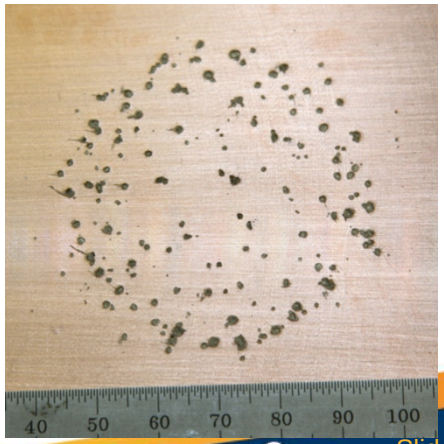
Fratricide – Sympathetic Reaction



Massive fragments

'Cornflakes'

Very small fragments



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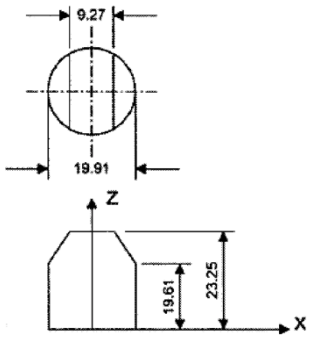
Ballistic insult test sources at LANL

- 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

‘Disposable’ 0.50 gun & test set-up

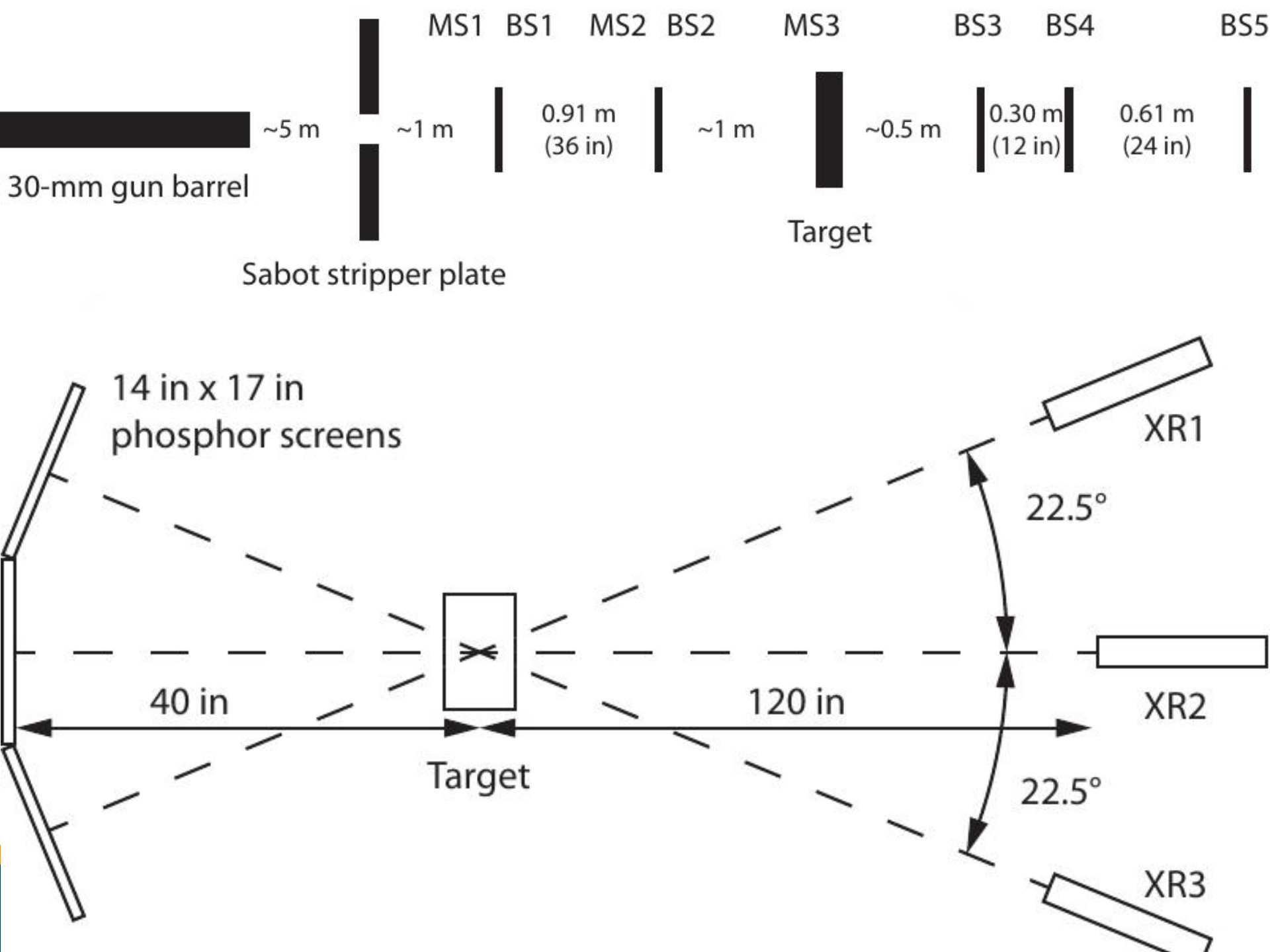
Fragment Simulating Projectile (FSP)



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

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

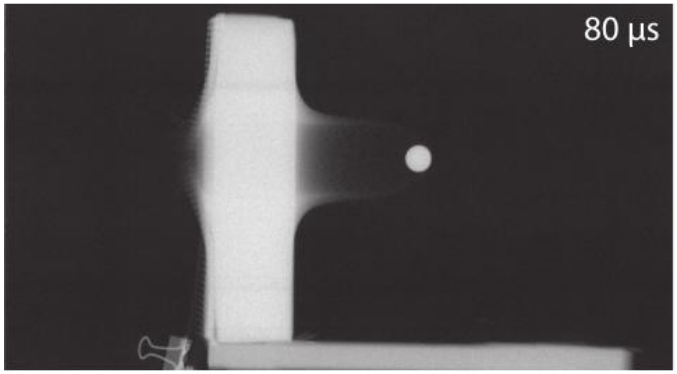
Using universal tracked chassis from M110 self-propelled howitzer


MS1
BS1
MS2
BS2
MS3
BS3
BS4
BS5
~5 m
~1 m
0.91 m
(36 in)
~1 m
~0.5 m
0.30 m
(12 in)
0.61 m
(24 in)
30-mm gun barrel
Target
Sabot stripper plate
14 in x 17 in
phosphor screens
XR1
22.5°
40 in
120 in
XR2
Target
22.5°
XR3

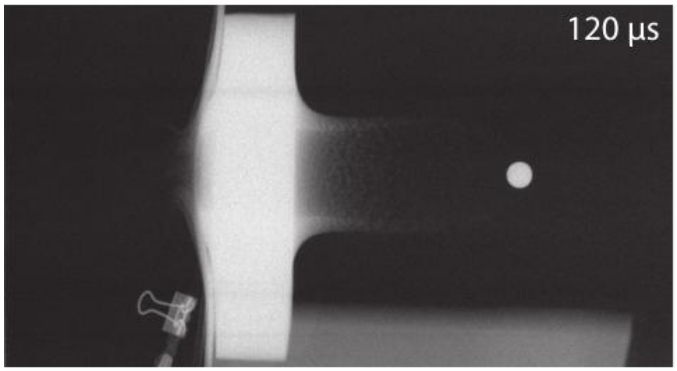
1620 m/s


40 µs


Photron
FASTCAM-APX RS mod...
0 µs


80 µs

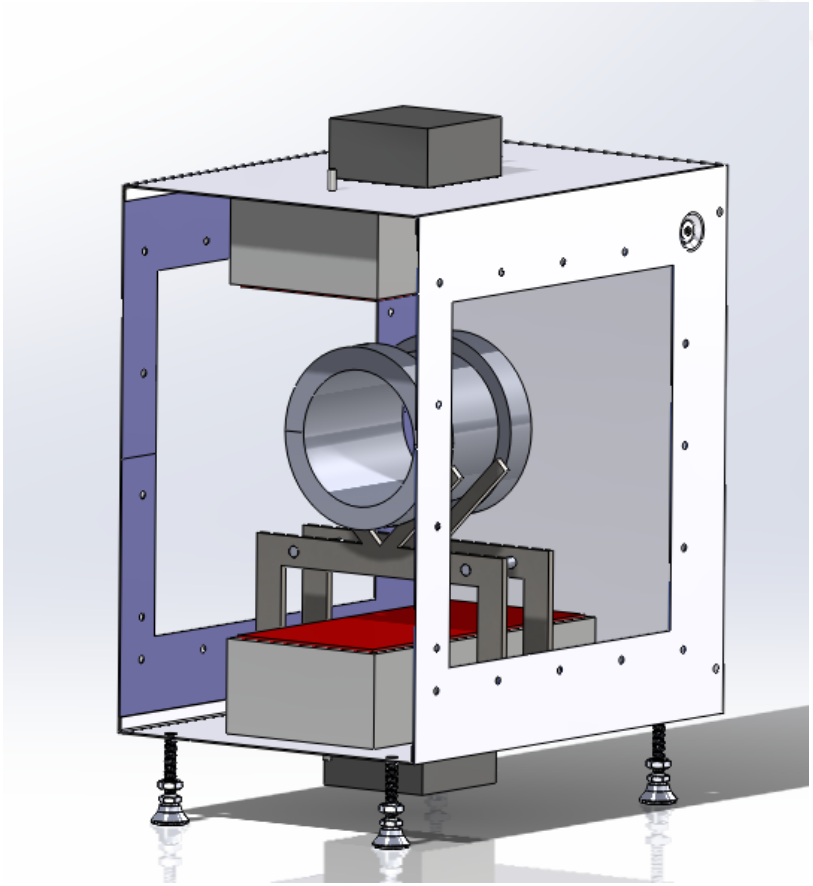

Photron
FASTCAM-APX RS mod...
333 µs


120 µs

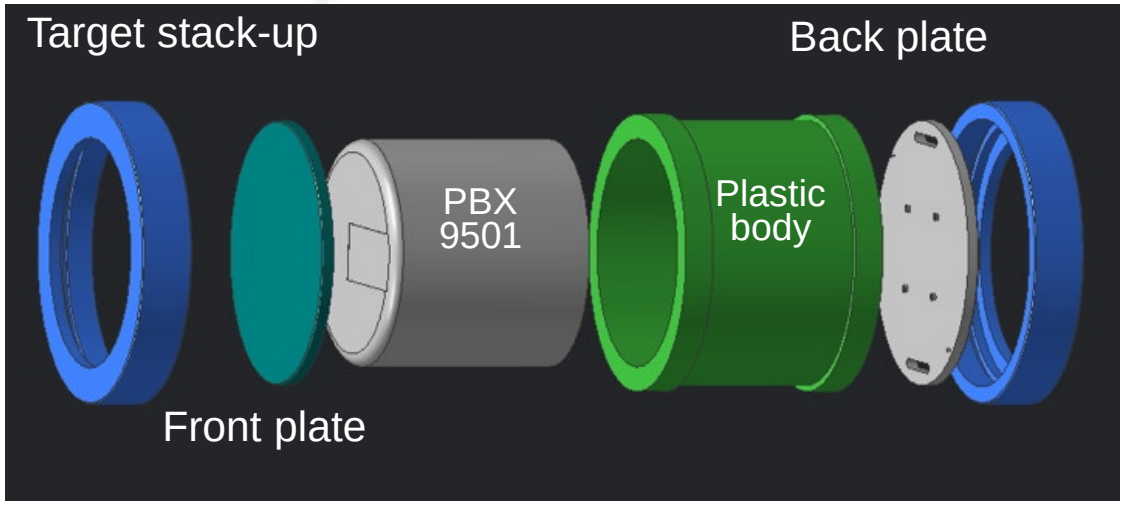

Photron
FASTCAM-APX RS mod...
667 µs

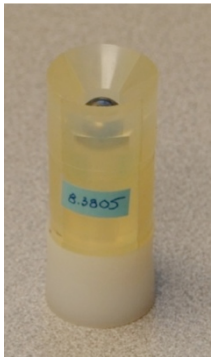
(a) (b)

New capability to heat target to 250C



Ball impacts on PBX 9501-filled targets





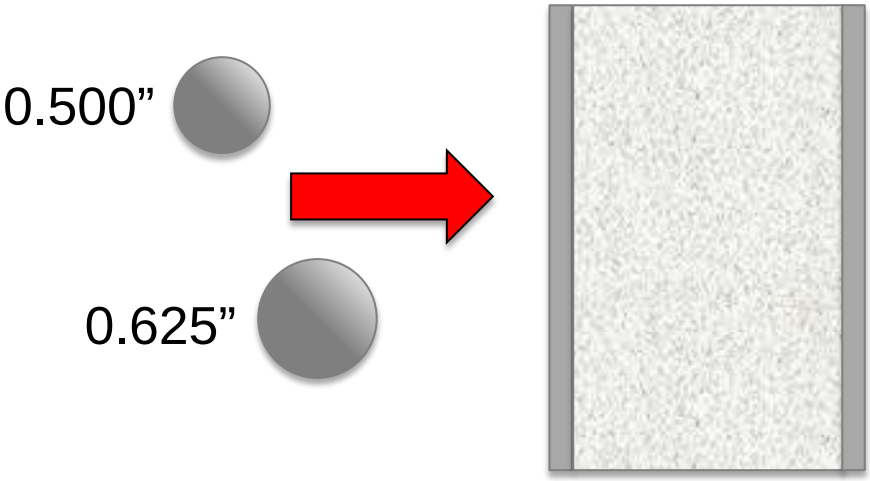
Modified sabots for optimum velocity and separation

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

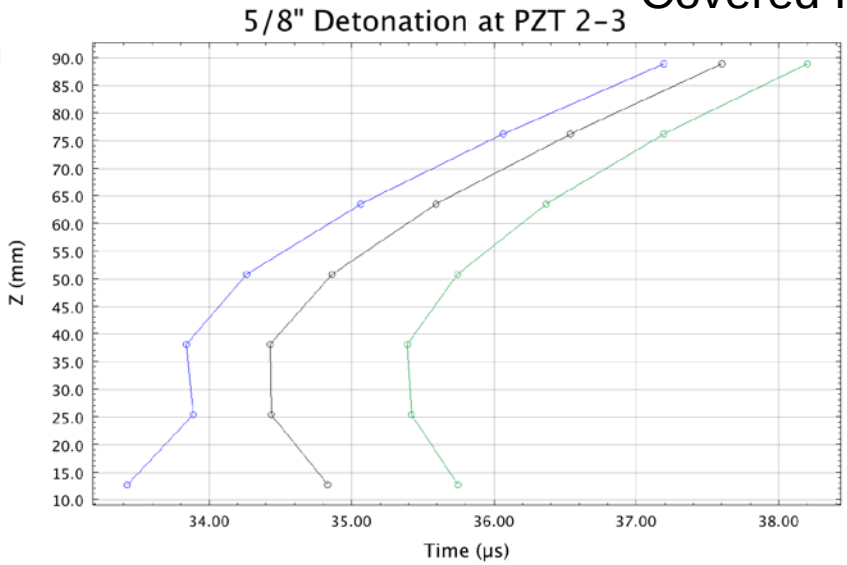
Single 1 MeV X-ray

3 PZT rails w/7 pins

But we could have also used PDV and microwave interferometry

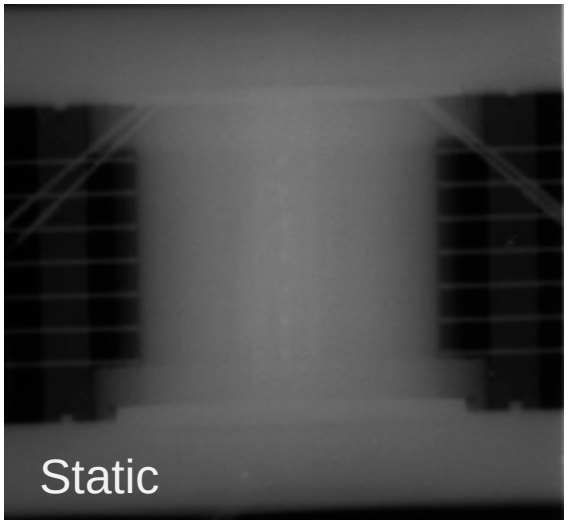
0.625 ball impact experiments

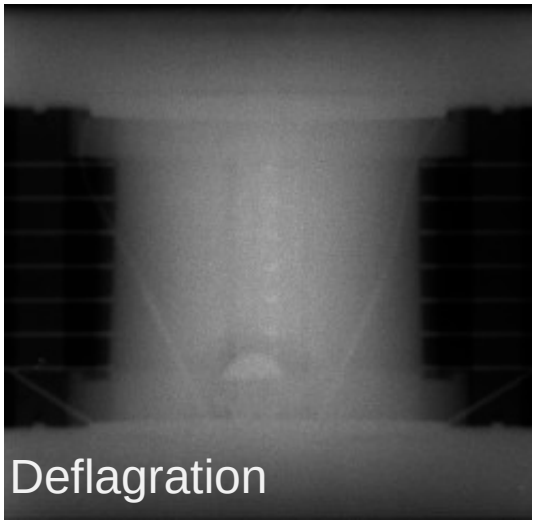
Covered PBX 9501, 0.125 inch 1018 Steel Plates

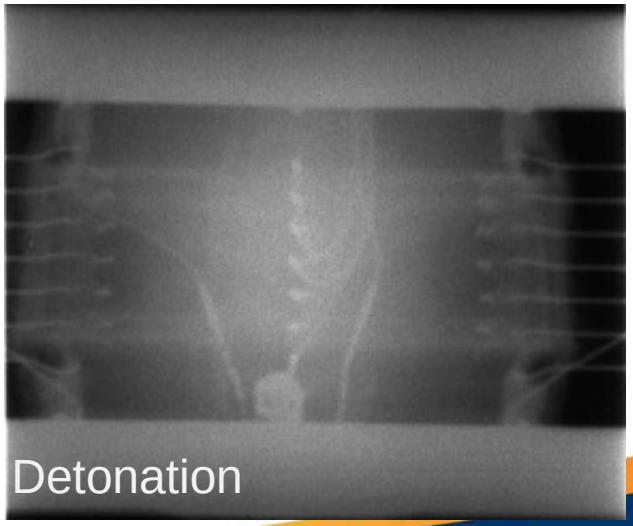


5/8" ball

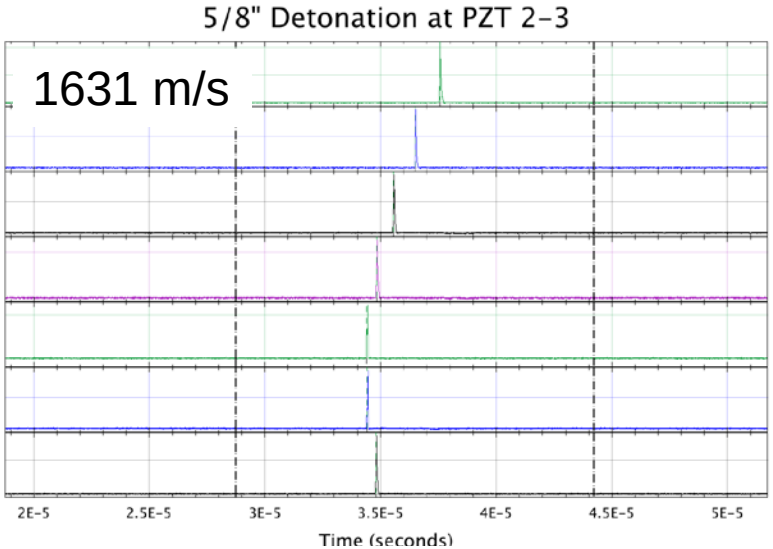
Charge (g)	Speed (km/s)	+/- (m/s)	Go/No-Go
190	1.669	1.5	N/A
190	1.631	∞	Det. at PZT 2-3
180	1.626	0.99	Det. at PZT 5-6
170	1.547	0.5	Deflagration
175	1.509	2.99	Deflagration
180	1.543	0.72	Deflagration





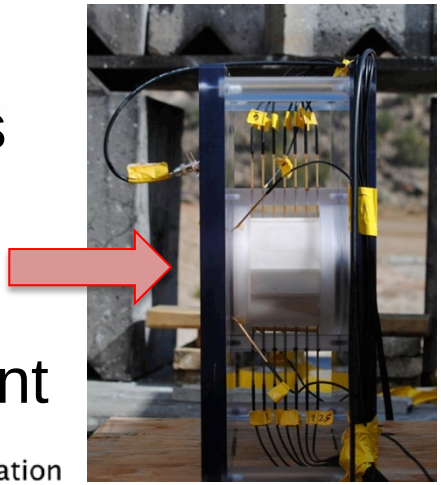


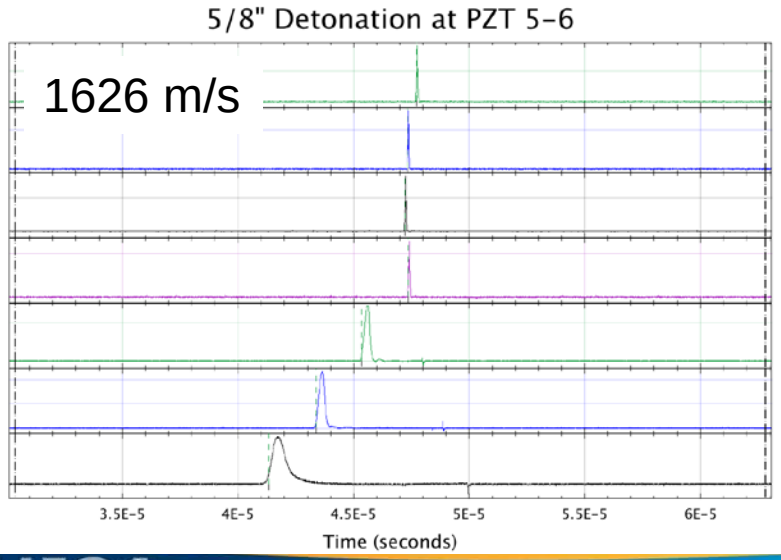
Ball impacts on PBX 9501-filled targets

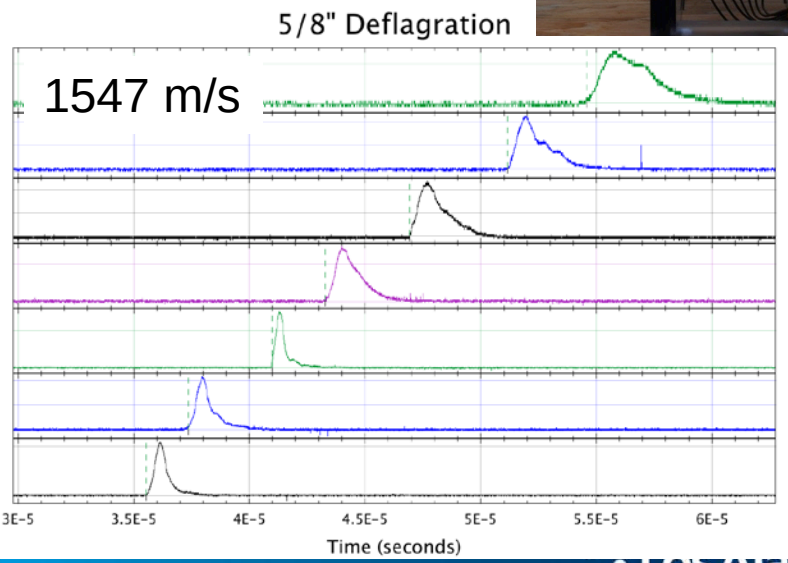


3 PZT rails w/7 pins

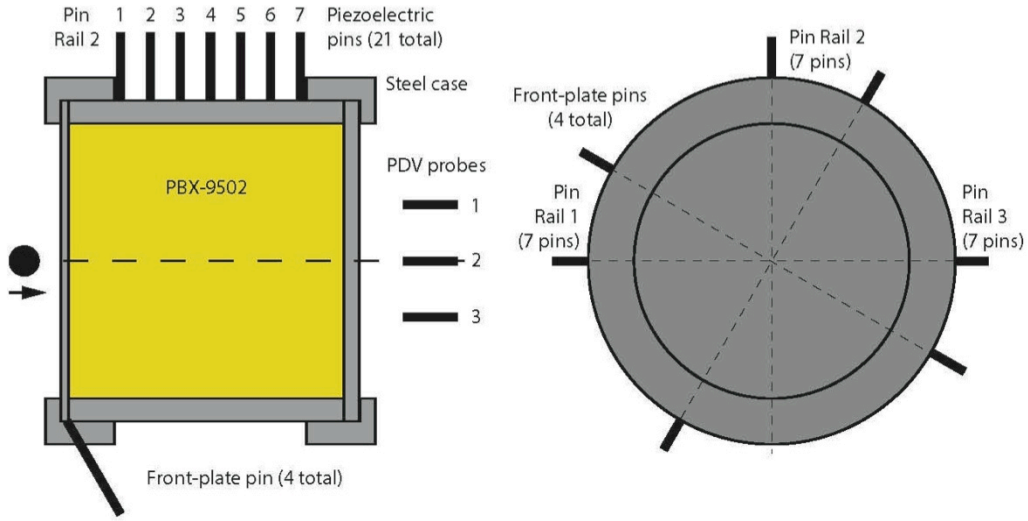
Timing &
'Content' of the event



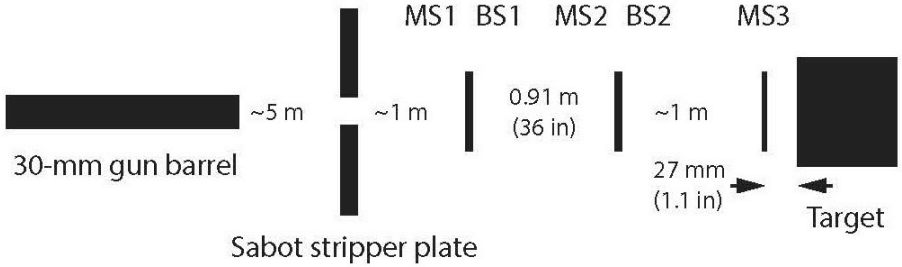




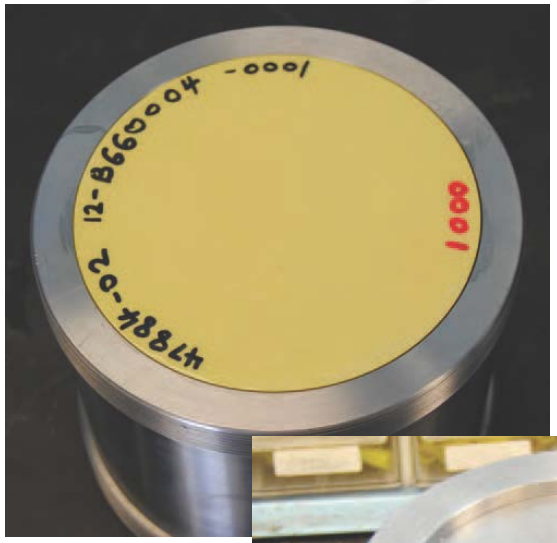
Make Up of Shot K12-21556 & test set-up



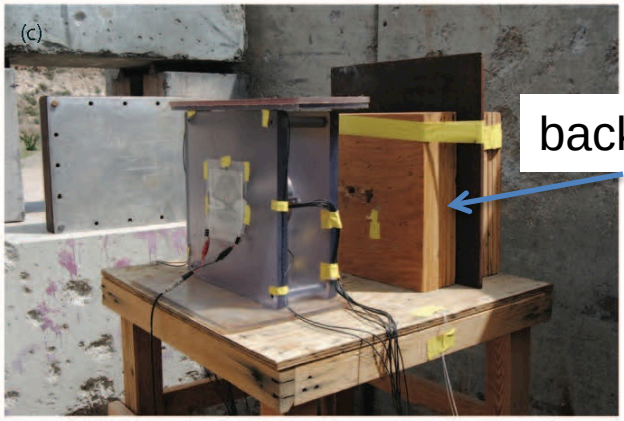
1018 steel case
0.125 / 0.25 1018 steel face plates
Carbon steel ball
V = 2.462 km/s



Views of hardware for Shot K12-21556

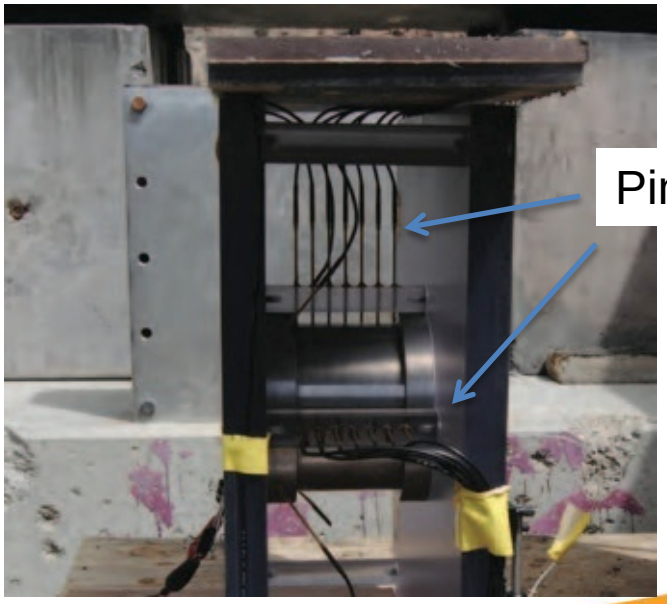


Front face before cover was installed



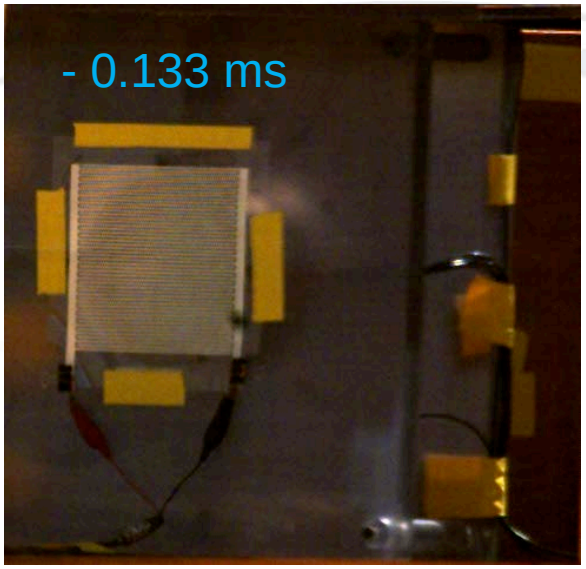
backstop

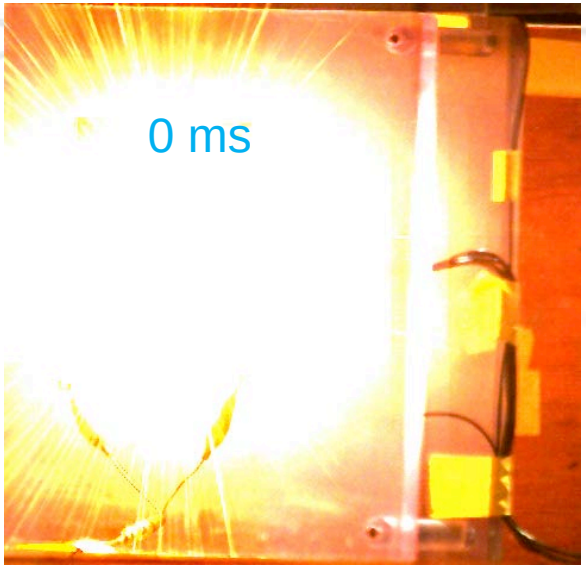
Assembled target – view of rear face

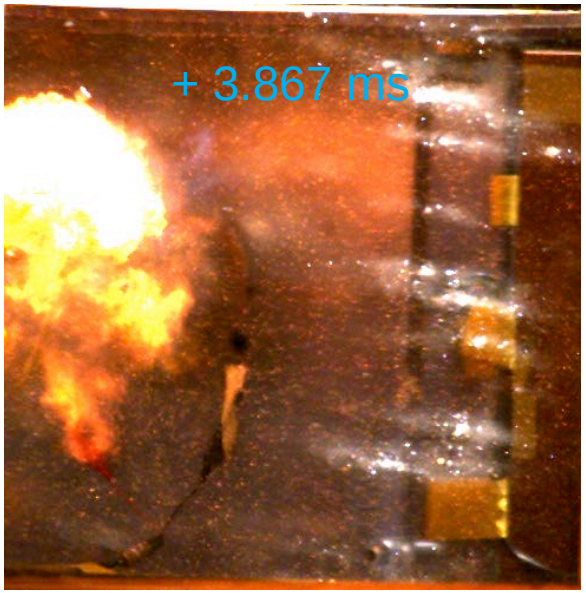


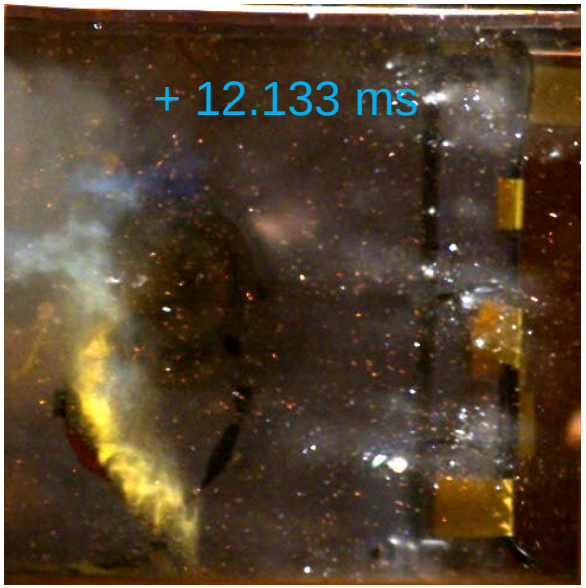
Pin rails

Pins to triangulate impact point









K12-21556

Bright flash followed by ~ 4 ms of combustion.

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

Ball did not emerge from assembly.

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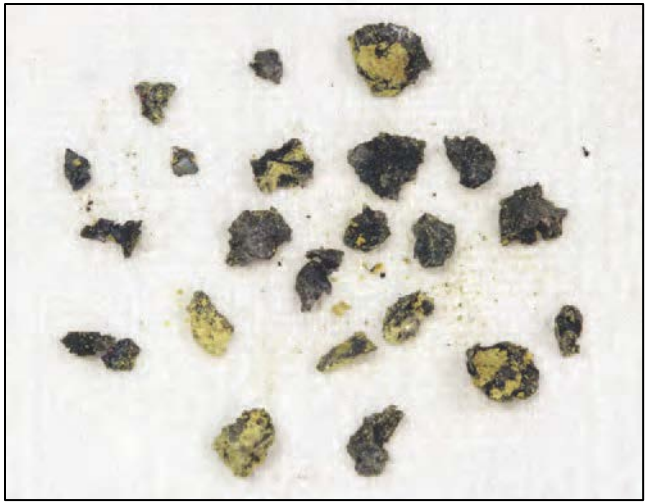
Recovered target from Shot K12-21556

Significant deformation of the 1018 face plate

Damaged PBX 9502 fill

Recovered bits from Shot K12-21556

Remnant of the low carbon steel fragment

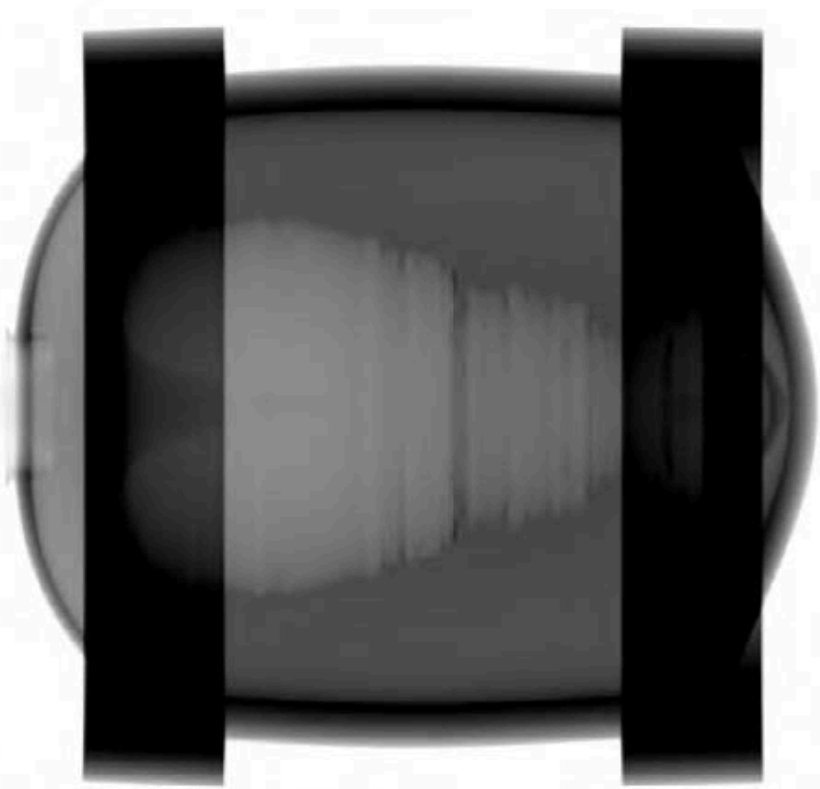


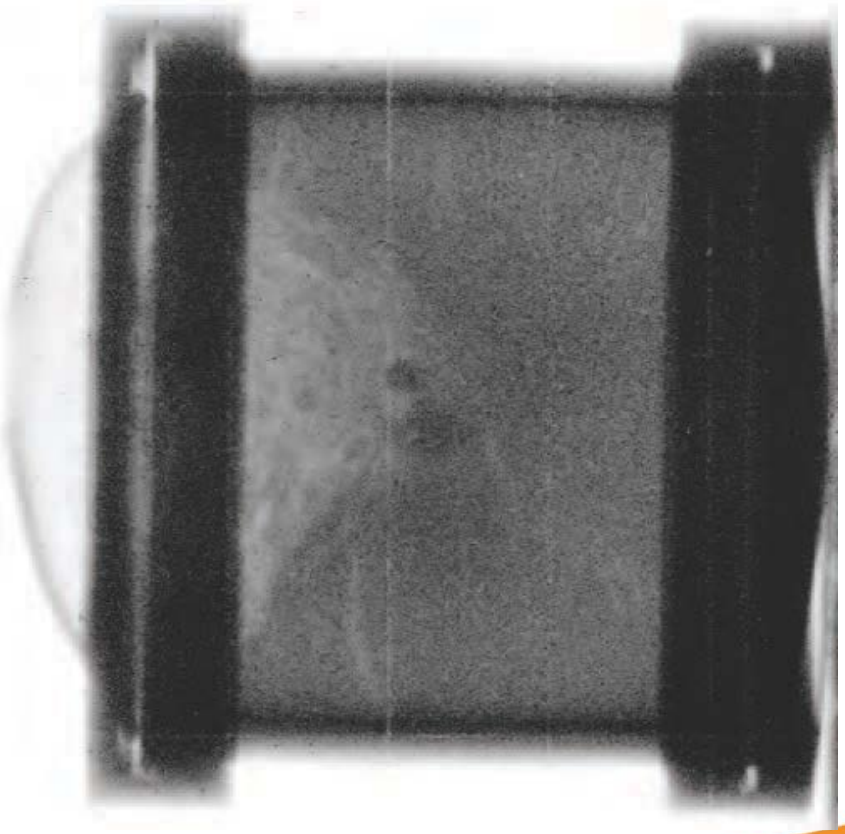
Smaller steel pieces recovered
– mixed cover plate and ball materials

PBX 9502 pieces recovered
– largest is about 3 cm wide

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.