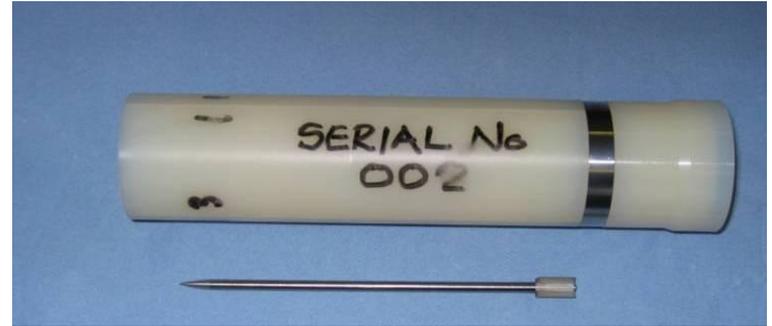


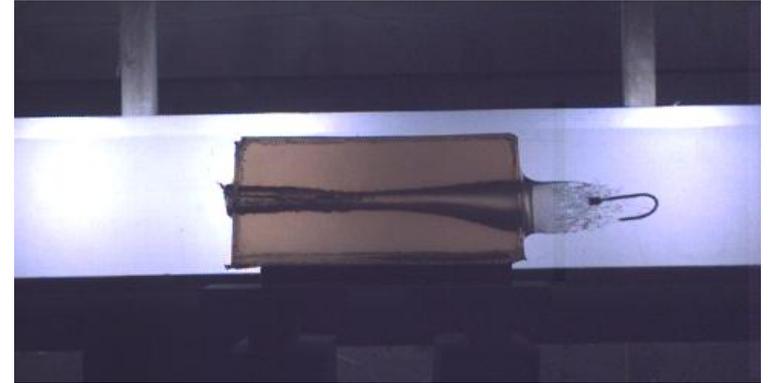
Experiments with Gun Launched Penetrators into Gelatin Target Materials

J. Stubberfield, C. Woodley, N. Lynch and A. Hepper
A presentation to: The 24th International Symposium
on Ballistics

25th September 2008

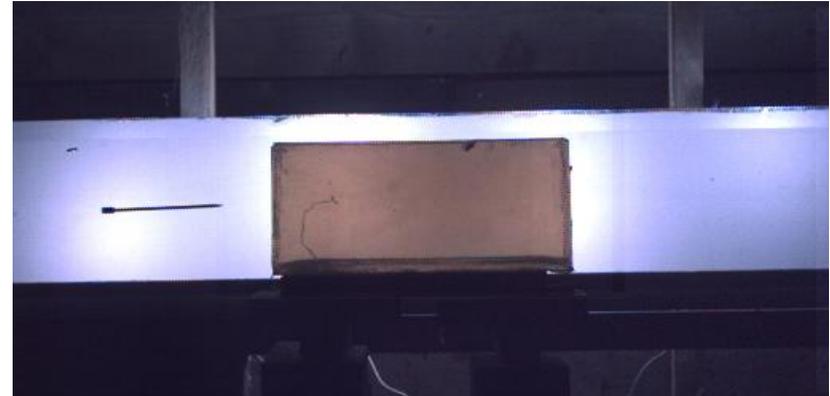


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- 04 Instrumentation
- 05 Experimental Set Up
- 06 Target Before Penetrator Interaction
- 07 The Effects of Pitch at Impact
- 08 Targets After Penetrator Interaction
- 09 Conclusions
- 10 Questions



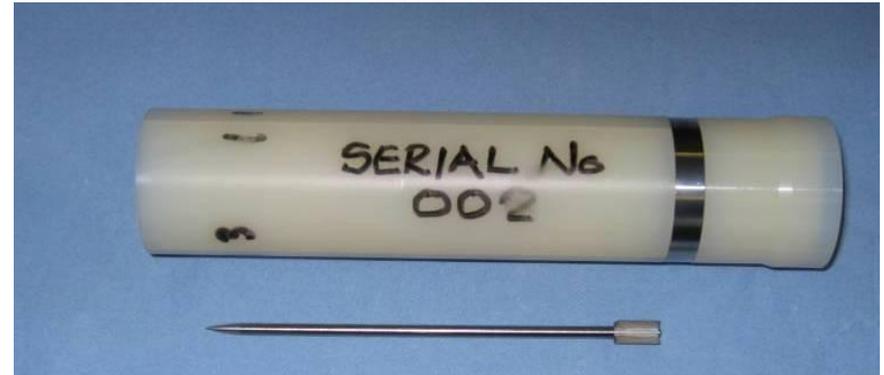
01

Penetrator and Launch Package Design



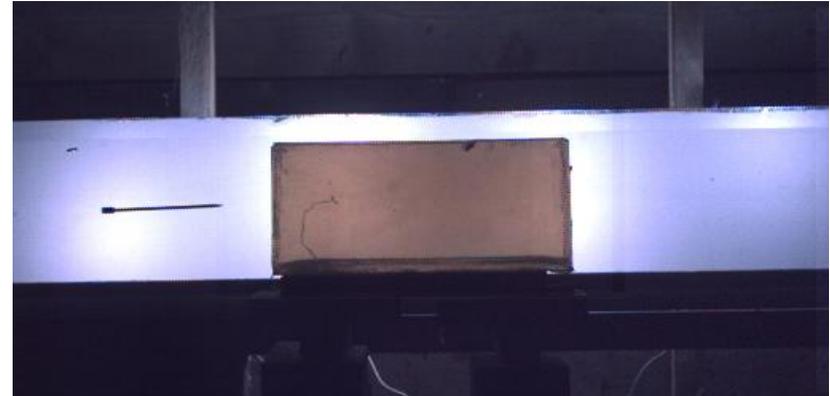
Launch Package Design

- “ Successful launch of unthreaded, high Length to Diameter (L/D) ratio penetrator requires careful design
- “ Need a light-weight launch package which fully supports the penetrator within the sabot
- “ Close fitting engineering tolerances to eliminate balloting in-bore
- “ Light-weight base pushed launch package
- “ Prevents penetrator buckling in-bore and flexing during its flight to the target



02

Interior Ballistic Modelling

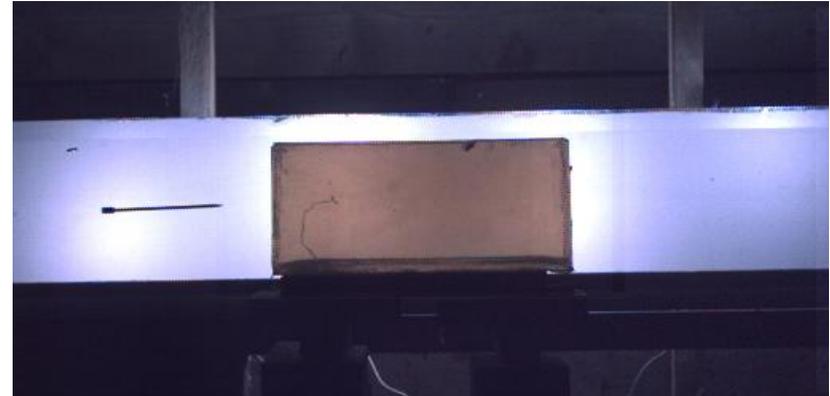


Modelling

- “ Selection of the correct Interior Ballistic (IB) solution critical for success
- “ One dimensional codes can predict muzzle velocities, maximum peak chamber pressures, maximum shot base pressures and other critical characteristics
- “ Codes identify efficient charge designs to avoid catastrophic effects to the gun system
- “ The parameters within the code can be used to condition a launch package in-bore, over the longest possible distance and thus creates what is described as a soft launch phenomena
- “ The QinetiQ Internal Ballistics Simulation (QIBS) version 2.7 was used to predict the IB solution.

03

Choice of Gun System



System

- “ 40mm calibre long barrel, smooth bore powder gun system
- “ Muzzle velocities from ~300m/s to ~2700m/s can be achieved.
- “ Gun system is a three section, smooth bore barrel system with an overall length of 10 meters
- “ The barrel is supported over its length with three tripods
- “ One-piece ammunition system and a modified Bofors 40/70 cartridge case



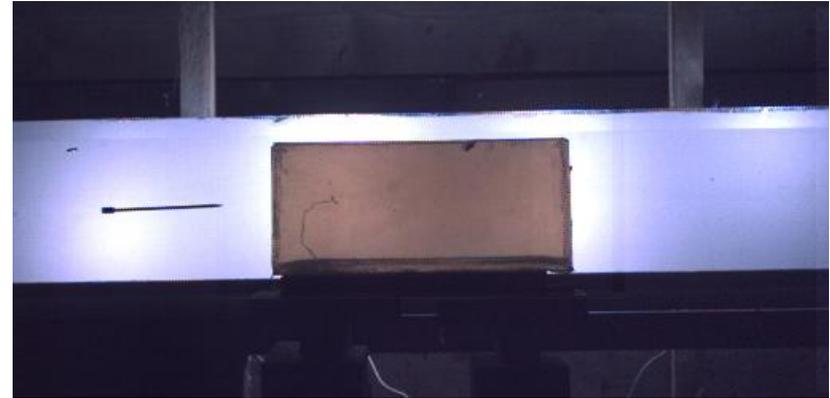


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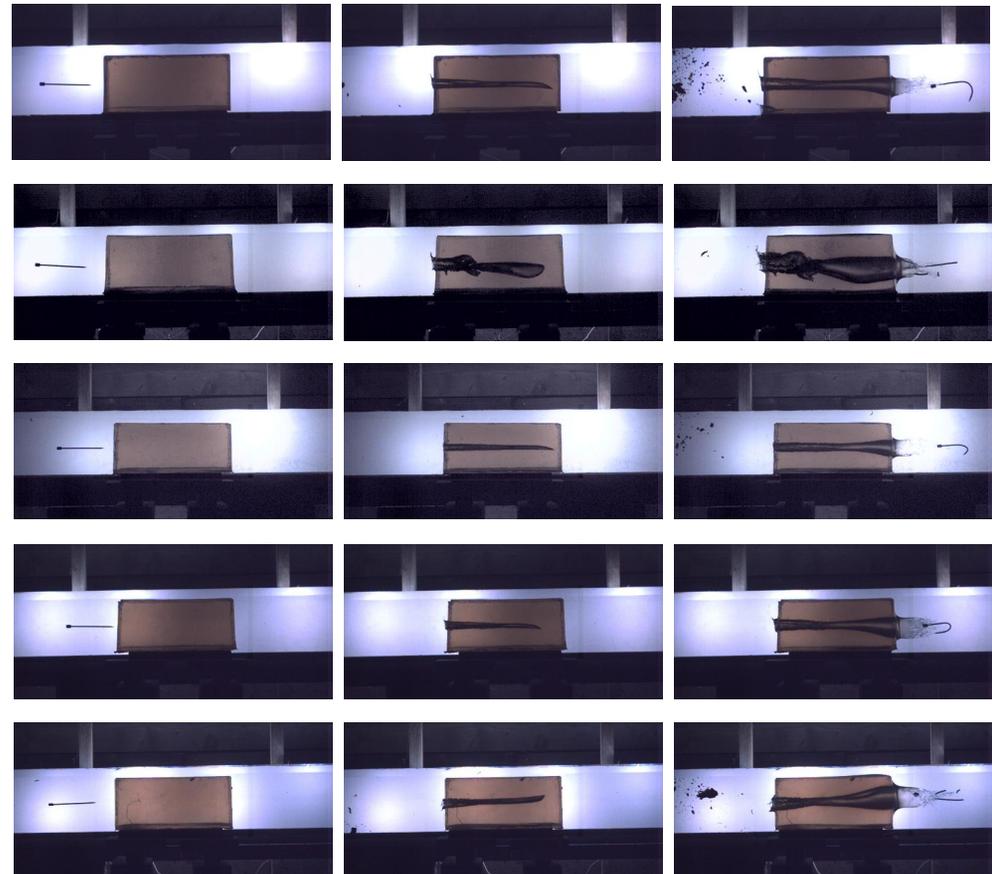
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04

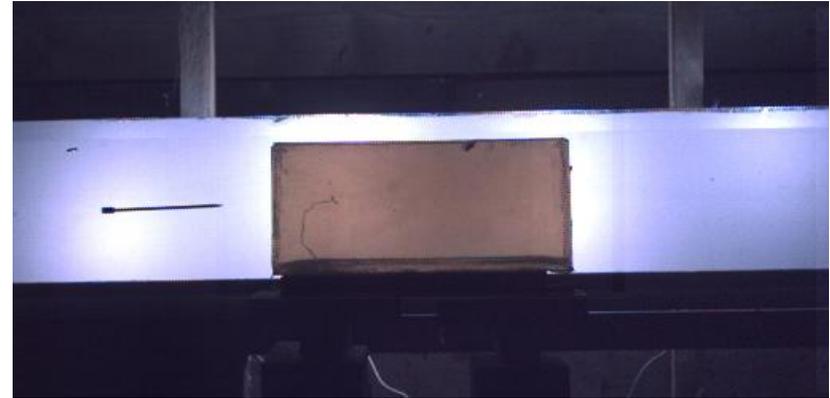
Instrumentation



- “ High speed video techniques enabled the study of penetrator interactions and penetrator impact and residual velocity data
- “ Penetrator pitch at impact and at exit and the related cavity formation determined
- “ Lighting techniques using a diffuser screen and sequential flash bulbs enabled a long capture duration to be used

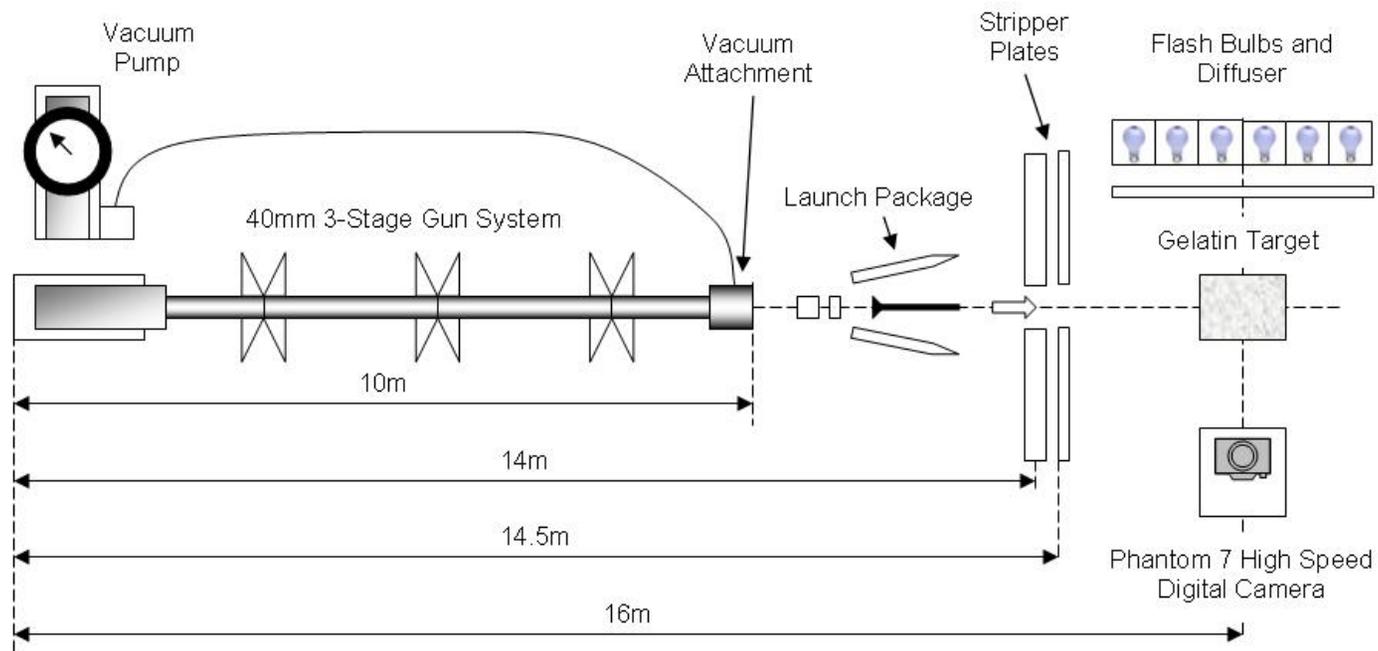


05 Experimental Set Up



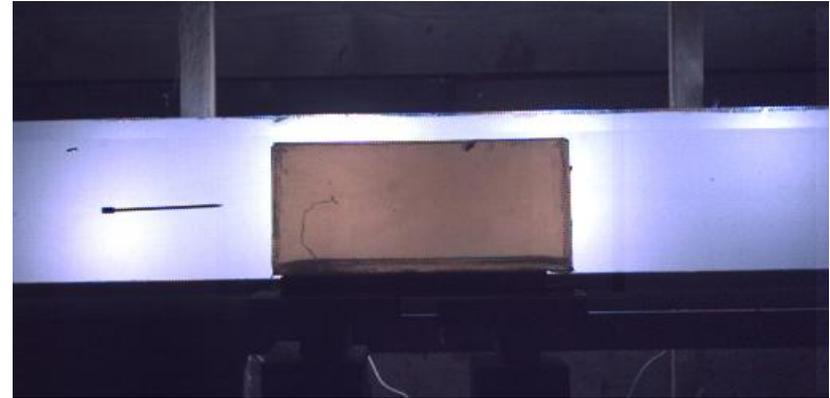
Set Up

- Outline diagram showing the overall set up used for the experiments



06

Target Before Penetrator Interaction



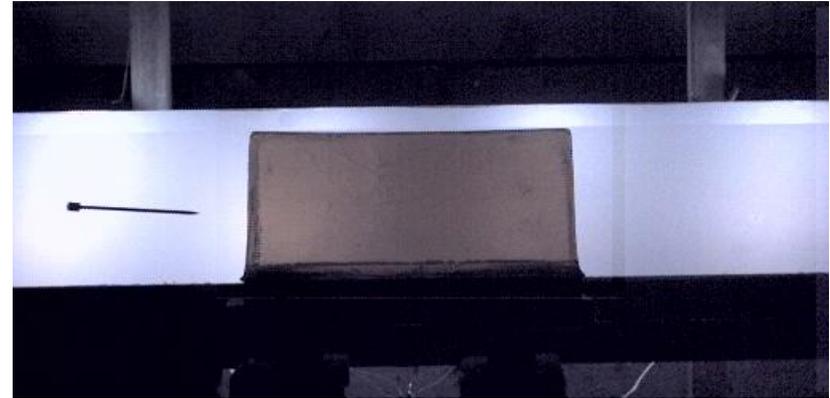
Penetrator Interaction

- “ Targets mounted on a wood platform as the Gelatin target material tends to be mobile in nature
- “ Target rear illuminated to observe the penetrator interaction and cavity formation through the opaque Gelatin material
- “ Diffuser screen mounted between the flash bulb array and the target



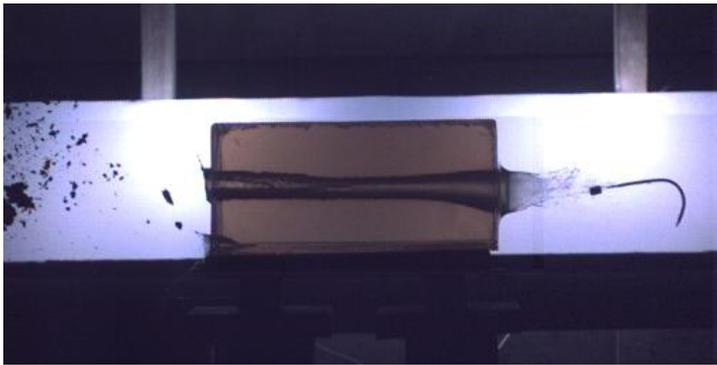
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The Effects of Pitch at Impact

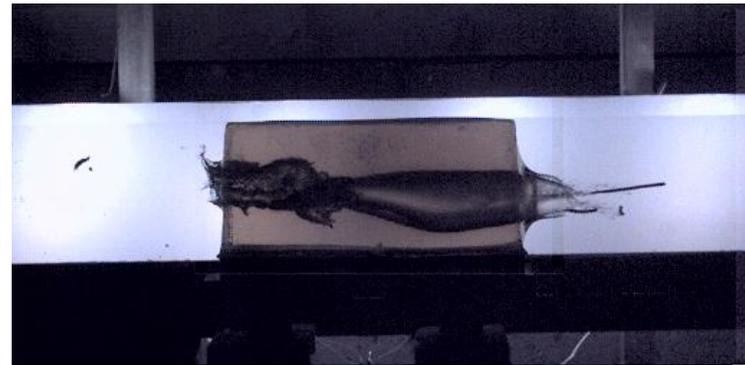


Negative Pitch at Impact

- “ Low negative pitch error: Penetrator exits the target in a severely bent condition
- “ High negative pitch error: Penetrator exits the target in a broken condition, breaking occurs during interaction with the target



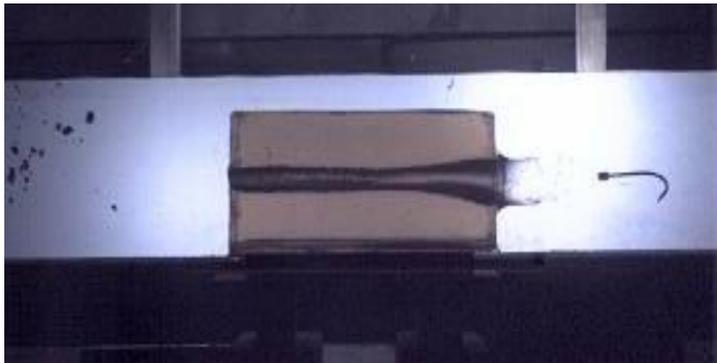
High Speed video of a low
negative pitch impact



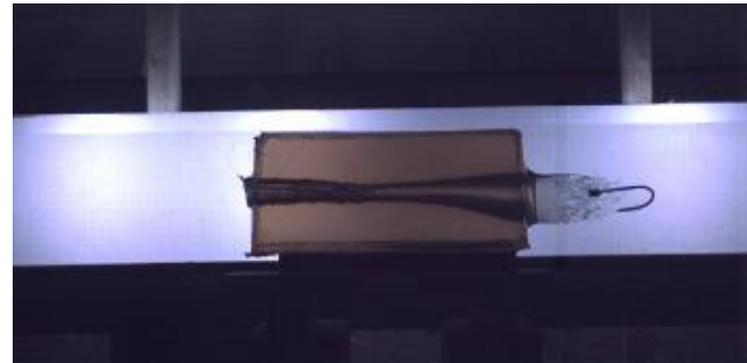
High speed video of a high
negative pitch impact

Very Low Negative Pitch at Impact

- “ Low and Very low negative pitch: Penetrator exits the target in a severely bent condition
- “ In both cases the bending is seen to be progressive during the interaction process and at exit with the target
- “ The severity of bending is linked to the impact error condition



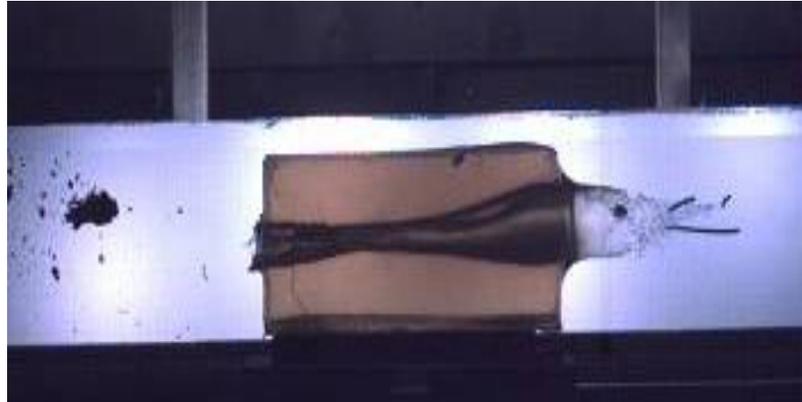
High Speed video of a very low negative pitch impact



High speed video of a very low negative pitch impact

Positive Pitch at Impact

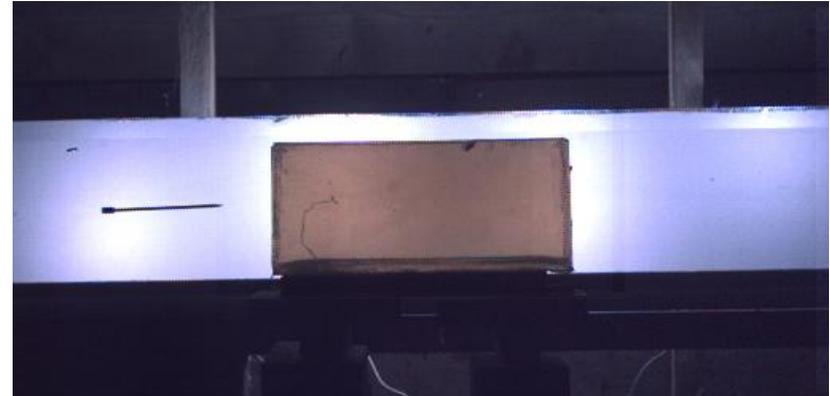
- “ Positive pitch at impact: Penetrator again exits the target in a broken condition breaking-up during interaction with the target



High Speed video of a
positive pitch impact

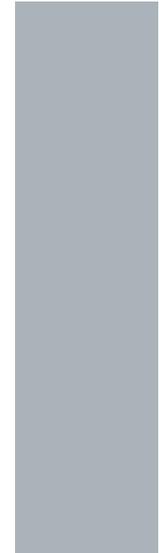
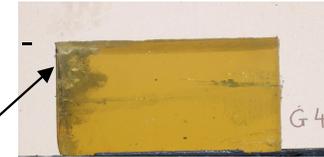
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Targets After Penetrator Interaction



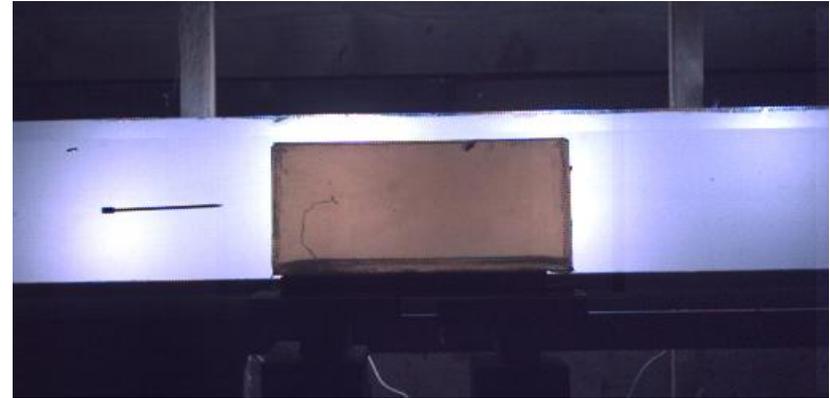
Penetrator Interaction

- “ With base pushed launch package designs, it can be difficult to eliminate residual material from interaction with the target
- “ Stripper plate removes majority of sabot petal component
- “ This residual material interacts with the Gelatin targets post penetration
- “ In most cases this was limited to the rear of the target and not considered detrimental to the formations of the observed cavities



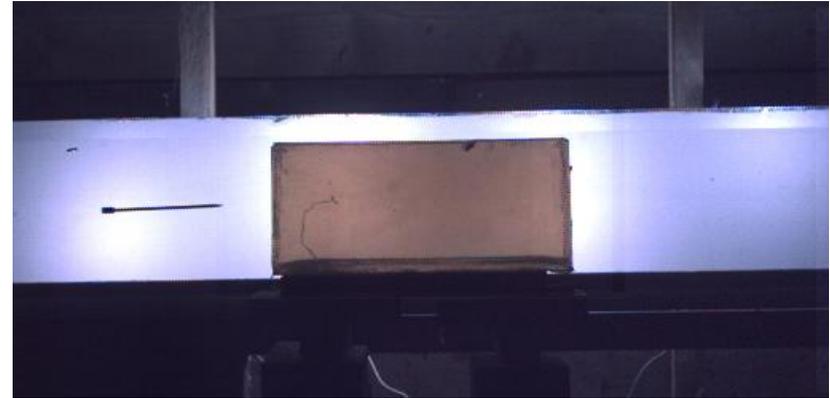
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Conclusions



- “ Unthreaded and high L/D ratio penetrators can be launched successfully
- “ Base pushed launch package designs can be used to launch these penetrators providing close fitting engineering tolerances are applied to the design
- “ IB modelling is an essential tool which identifies the correct design solutions
- “ Long barrel gun systems can be used to create soft launch phenomena
- “ High speed video techniques capture the penetrator performance at relatively low cost
- “ Low and very low negative pitch at target impact can produce a penetrator which is severely bent at exit from the target
- “ Higher pitch error at target impact can produce a penetrator which is broken into two or more pieces at exit from the target
- “ Impact condition is a contributing factor to projectile exit condition and cavity formation

10 Questions?





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