RAVEN

A New Species of Gun for the Objective Force

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Outline

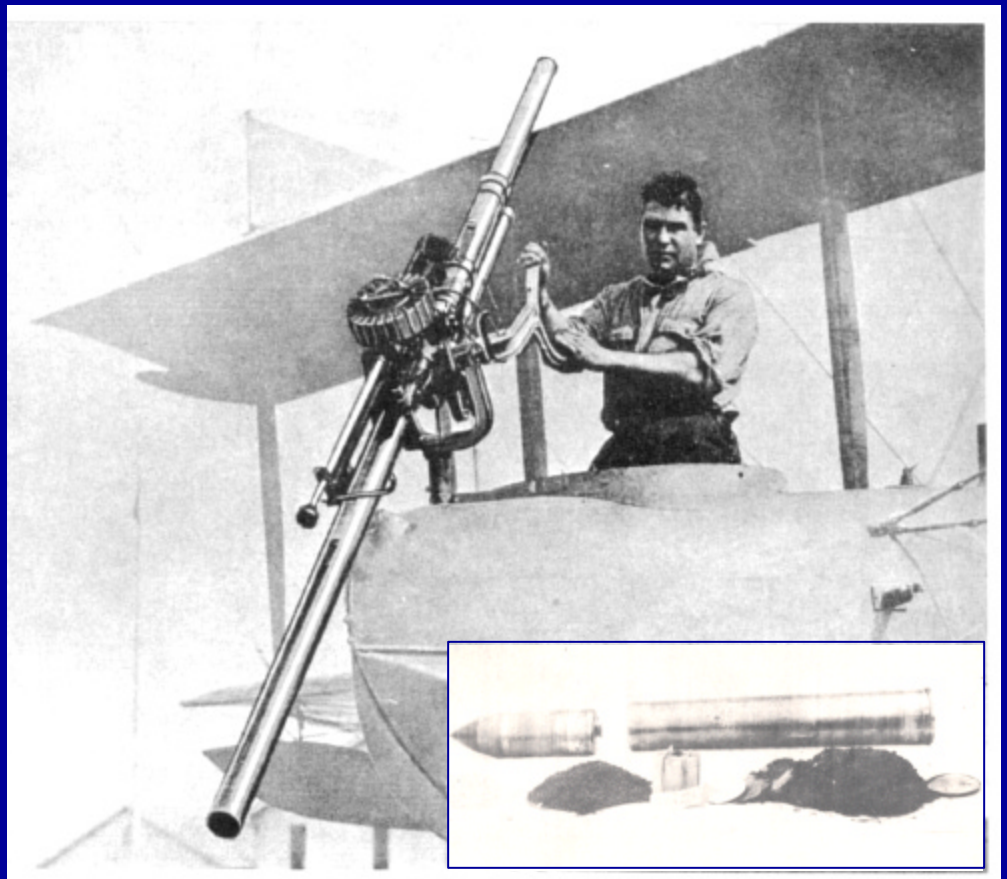
RAVEN

- RAVEN Concept
- 35mm RAVEN Implementation
- Experimental Results
- Comments on Blast
- Discussion of Results

Prior Art: DAVIS Gun

RAVEN

- Recoilless
- Accurate
- Capable of High Pressure Propulsion
- Drawbacks:
  - Inefficient
  - Weight
  - Back Blast & Back “Bullet”



Davis Gun Mounted for Anti-Submarine Patrol.

How it works

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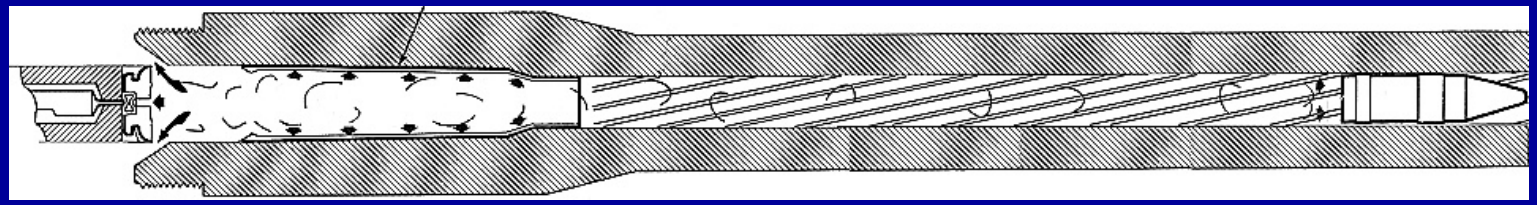
- Initial operation as a closed-breech gun.
- Upon a delayed venting of the chamber RAVEN operates as a recoilless rifle.
- The limiting velocity of the rarefaction wave released by the venting will reduce or eliminate any degradation in projectile propulsion.
- Analogy may be drawn to the rarefaction wave through the driver section of a shock-tube.

Inertial "Blow-Back" Breech



- Intentional rupture of cartridge case.
  - Compatible with combustible case technology.
- Breech travel governed by same propellant pressure that drives the projectile.
- Recoil stroke to vent port and recoil mass determine vent time.
  - Robust, reliable, potentially weaponizable . . . but not the only path forward.

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Picture of Test Fixture

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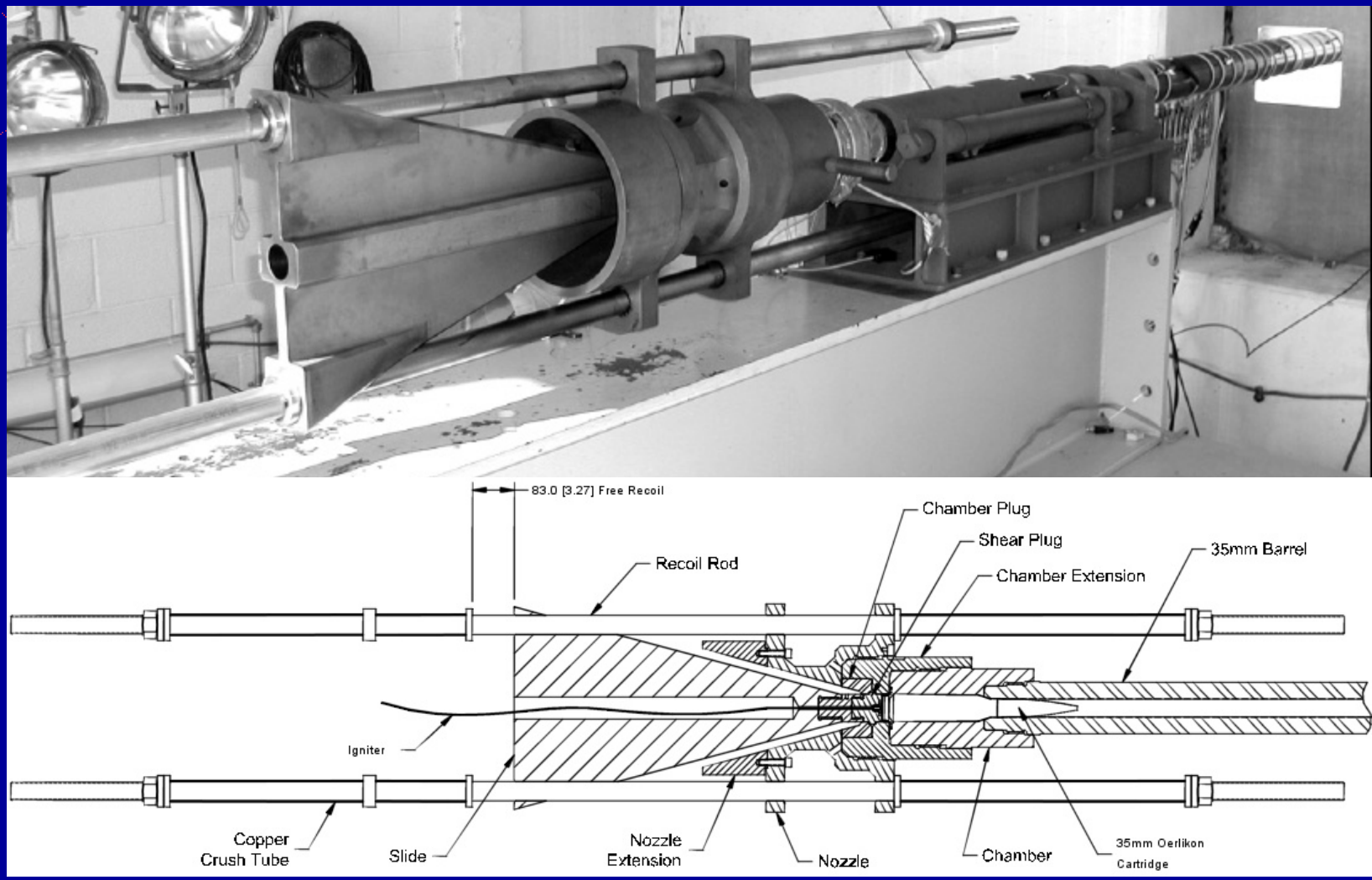

Oerlikon KD AA 35mm TP

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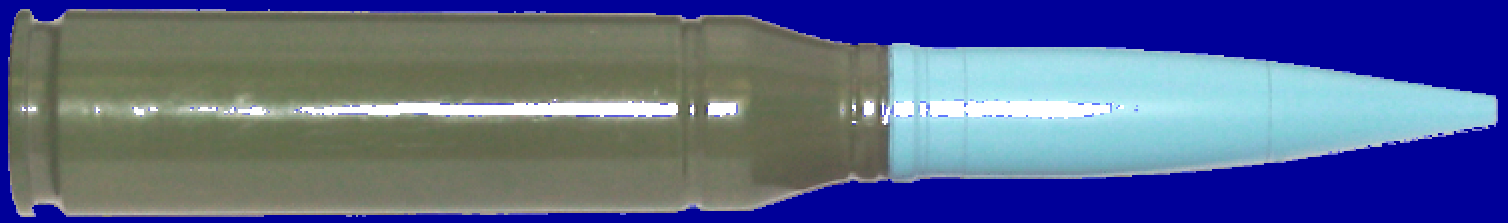
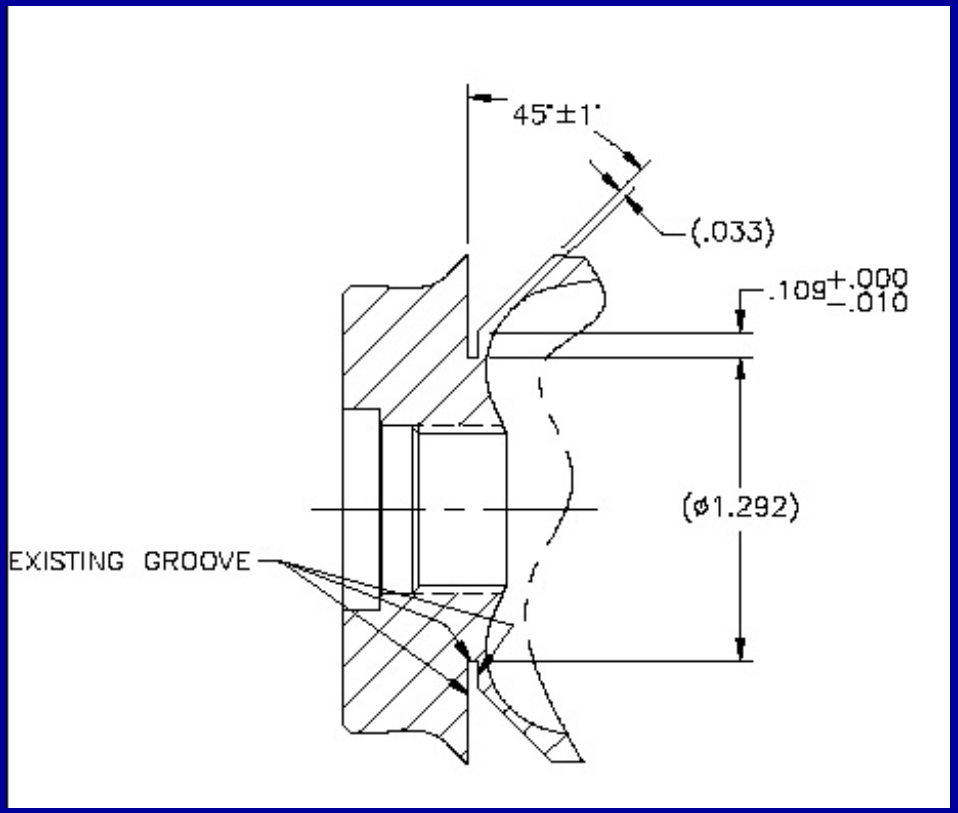
- 1,175 m/s
- 250 #s
  1,100 Ns
- 55 ksi
  383 MPa
- L 3.1m

- Mp = 0.55 Kg
- Mc = 0.33 Kg
- Mc/Mp = 0.60



Cartridge Case Notch



The back of the cartridge case was modified to incorporate a rupture notch & accommodate a nylon obturator band.

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Internal Workings of Test Fixture

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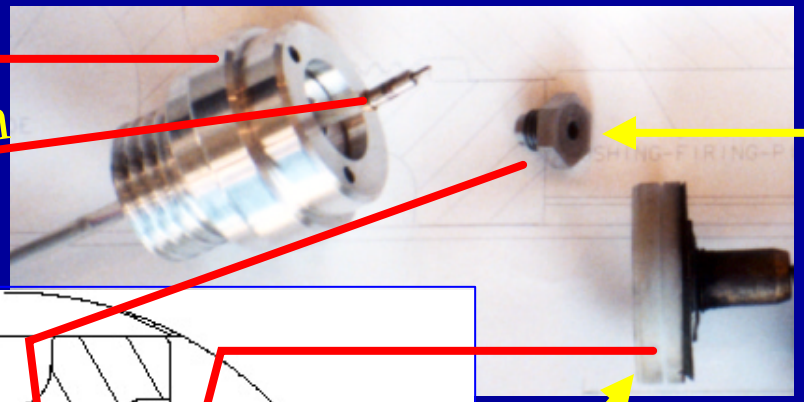
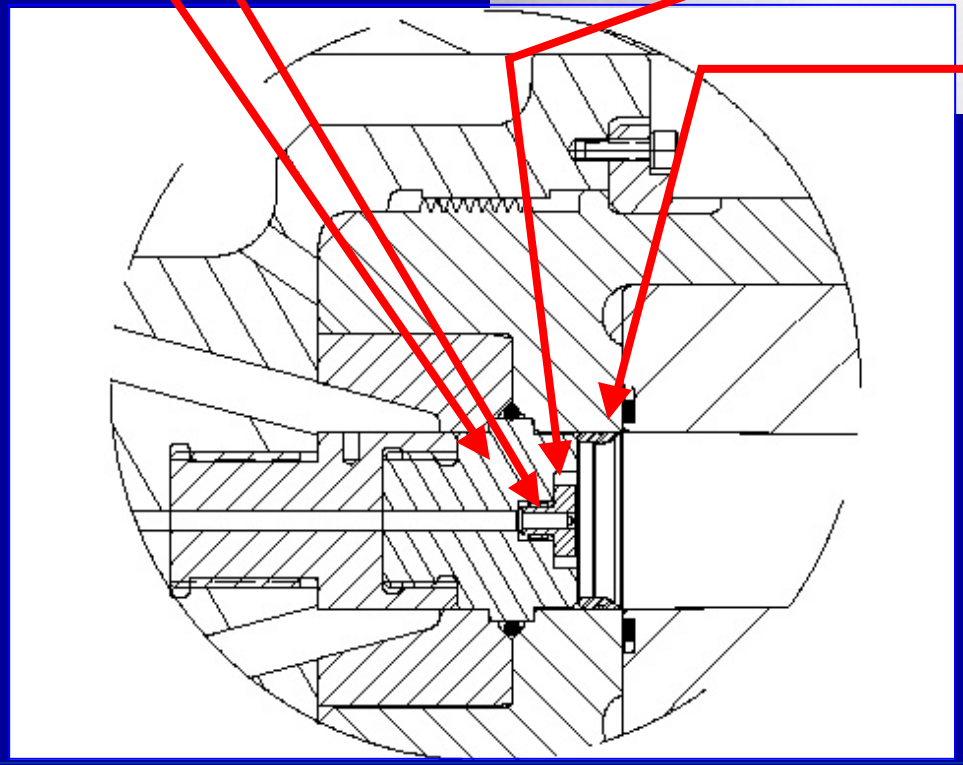
Shear Plug

Firing Pin Actuator

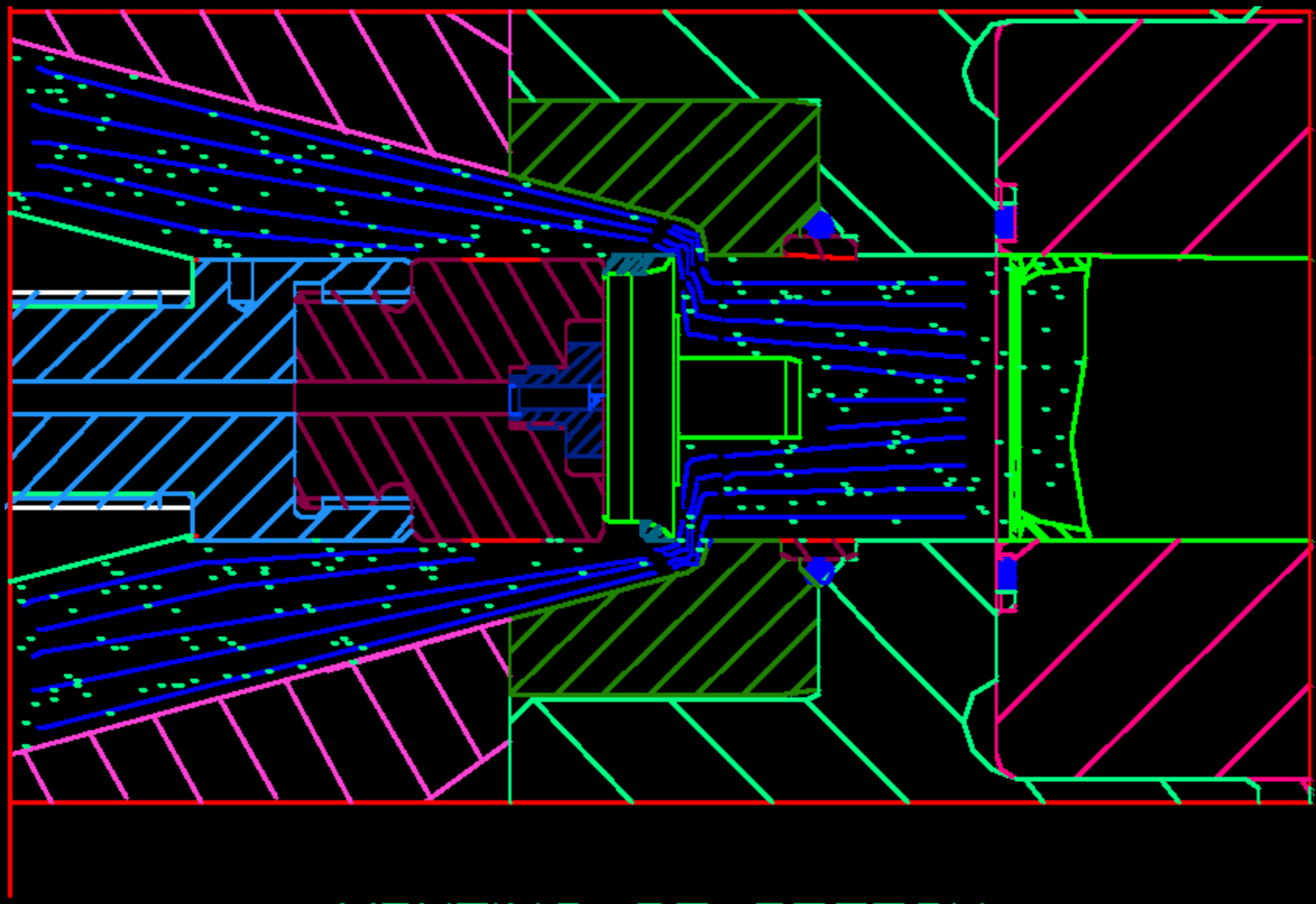


Firing Pin Bushing



Nylon Obturator Band Fit Over Case Head

Breech Operating Sequence



VENTING OF BREECH

ARES Test Range

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Erie Proving Grounds, Port Clinton, OH

ARES

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First Firing, 30 August 2001

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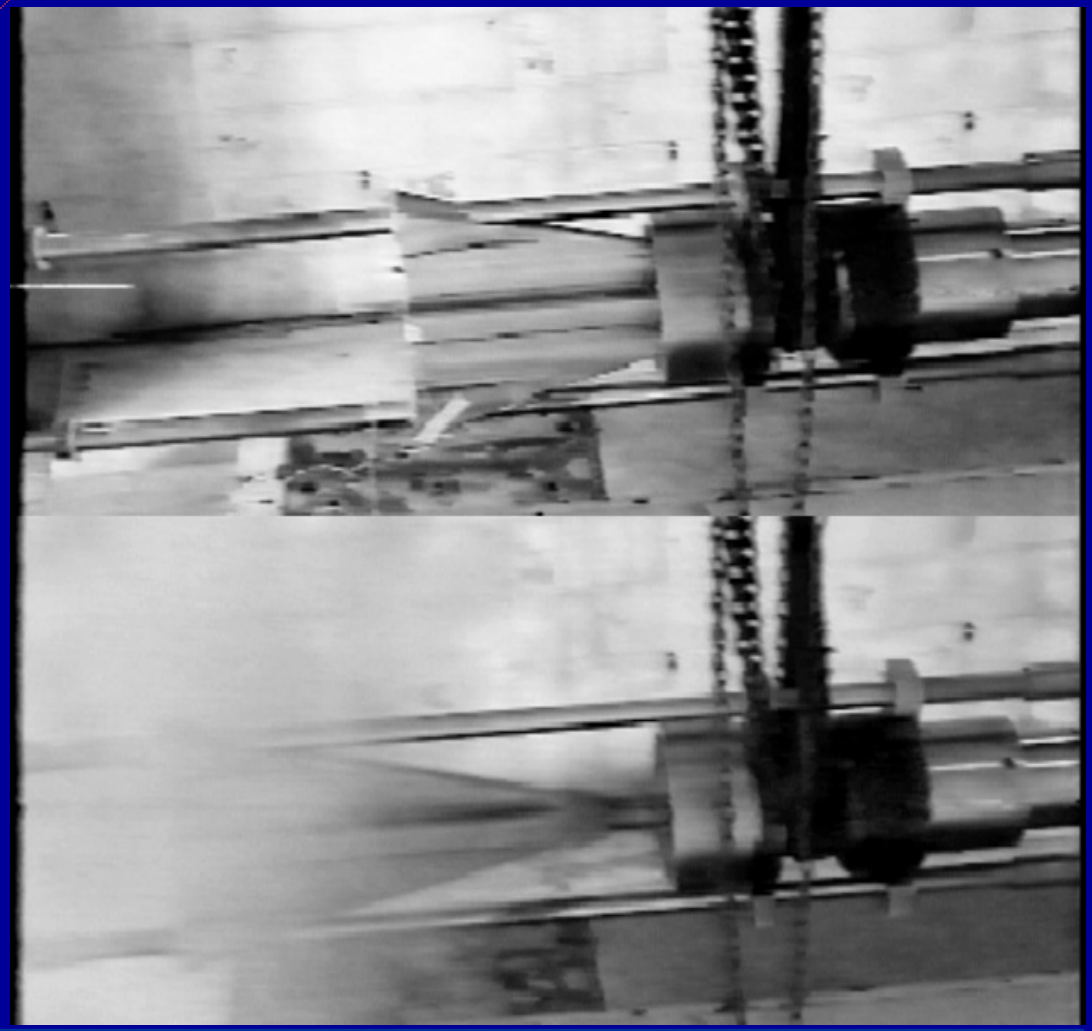

- Firing event

First Firing, 30 August 2001

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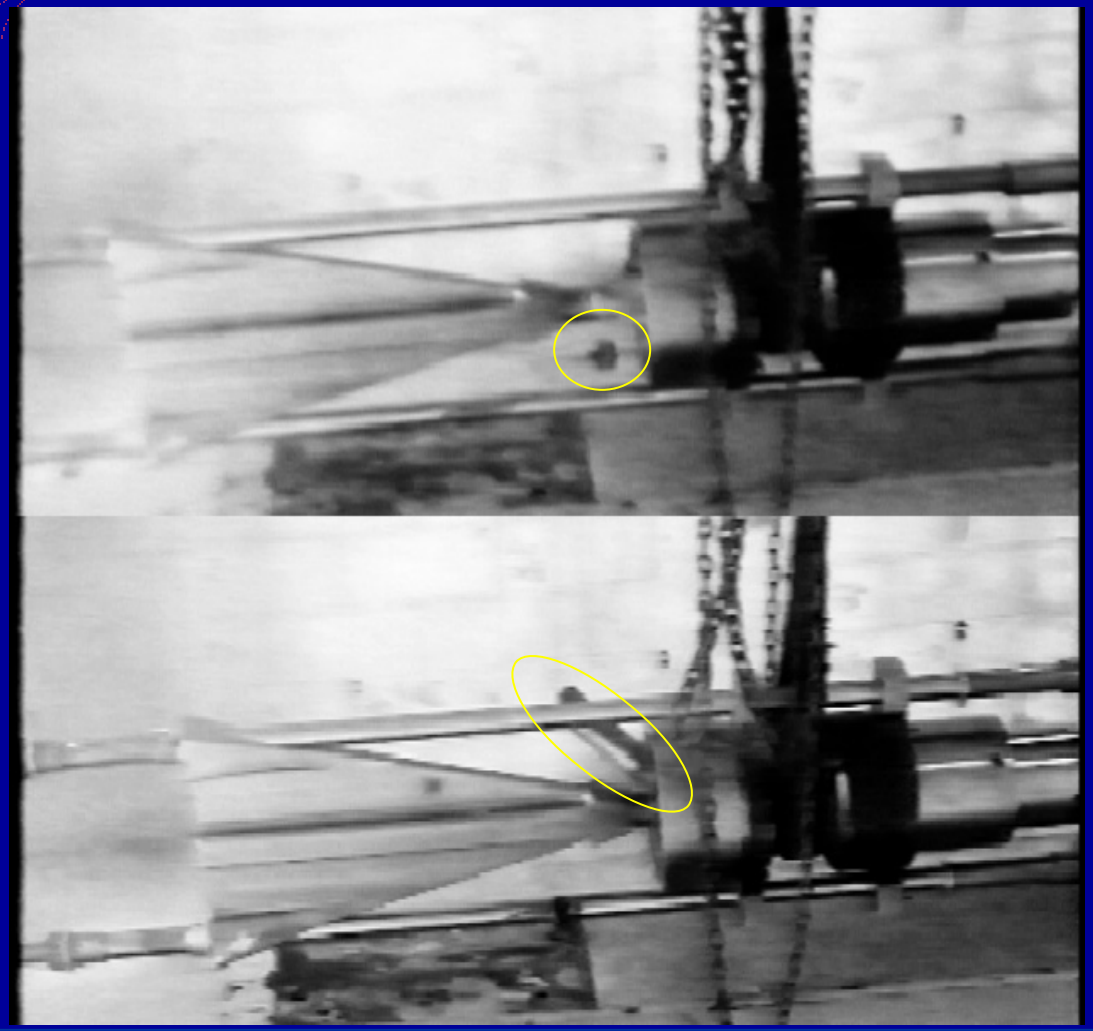

- Case Head Ejection
- Case Body Ejection

First Firing Video

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Primary Recoil

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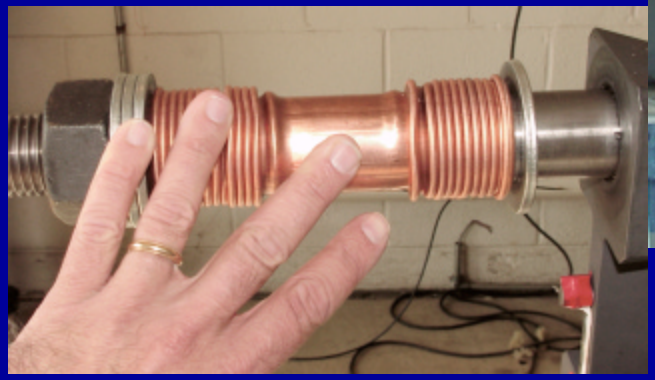
The primary recoil rods, utilizing simple copper plumbing tubing as crush tubes worked well.



Non-Venting Pressure Data

Inertial Blow-Back Breech

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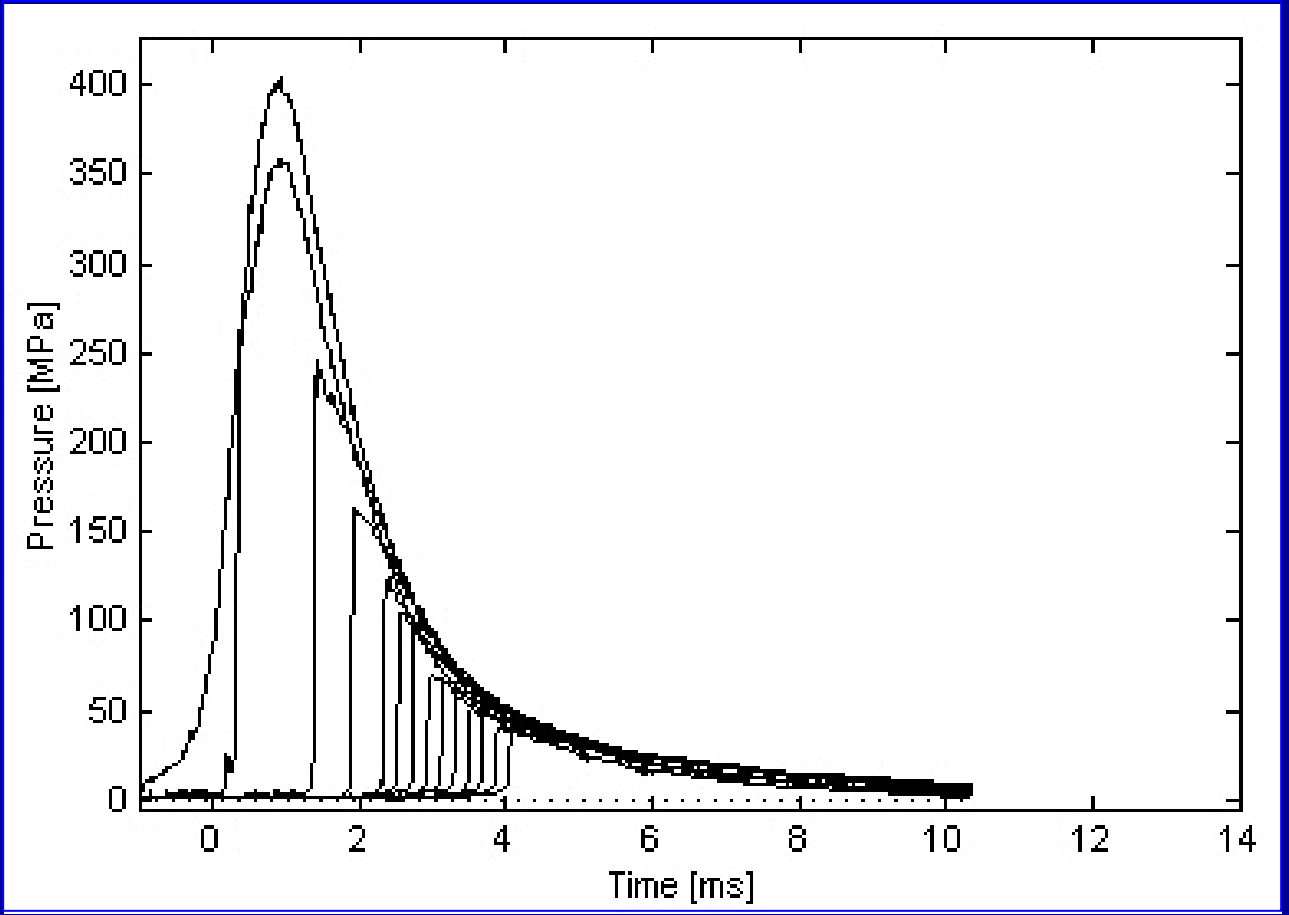

1135 m/s Muzzle Velocity 2-9-4

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Pressure Travel Time Curve

Inertial Blow-Back Breech

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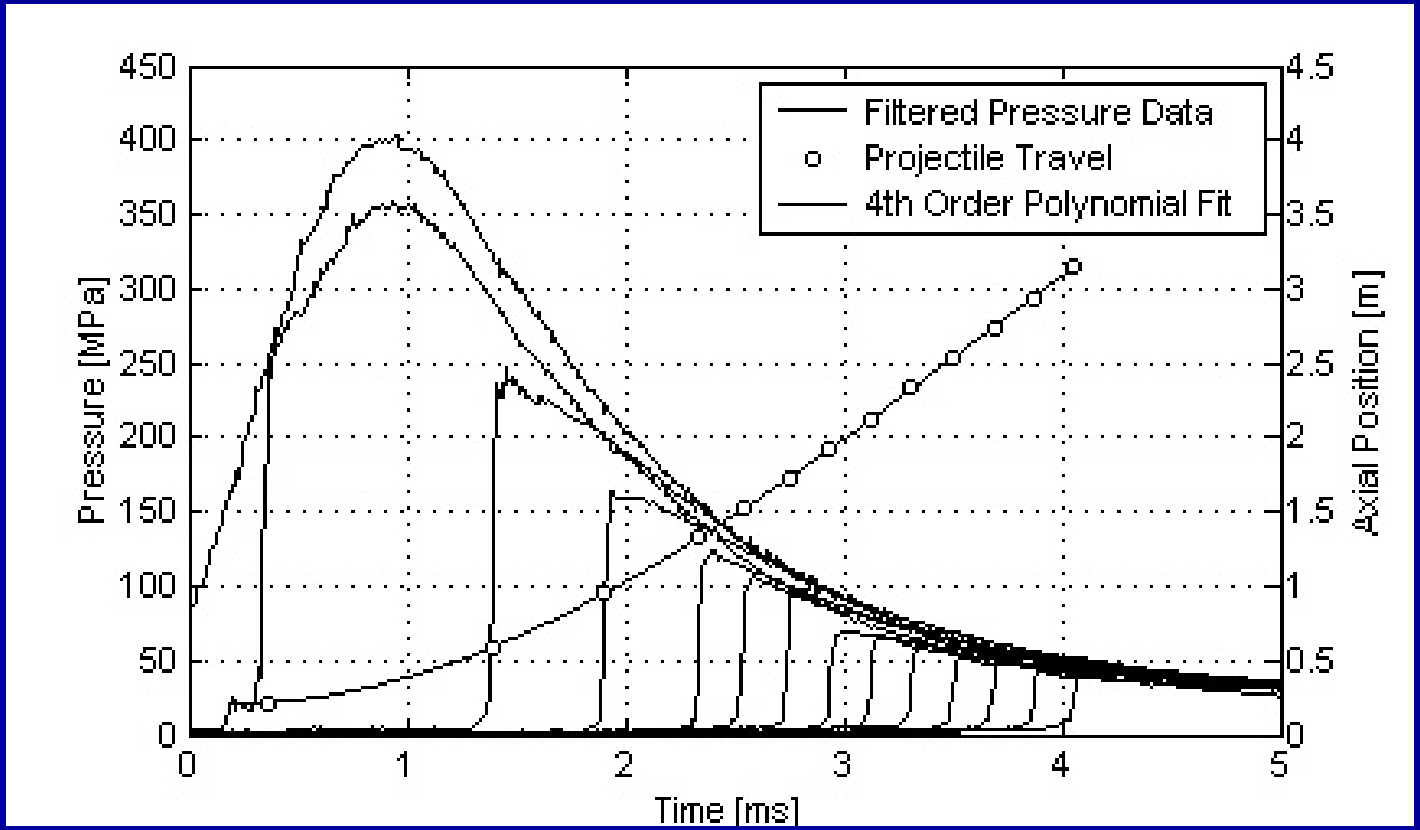

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Heavy/Early RAVEN Pressure Data

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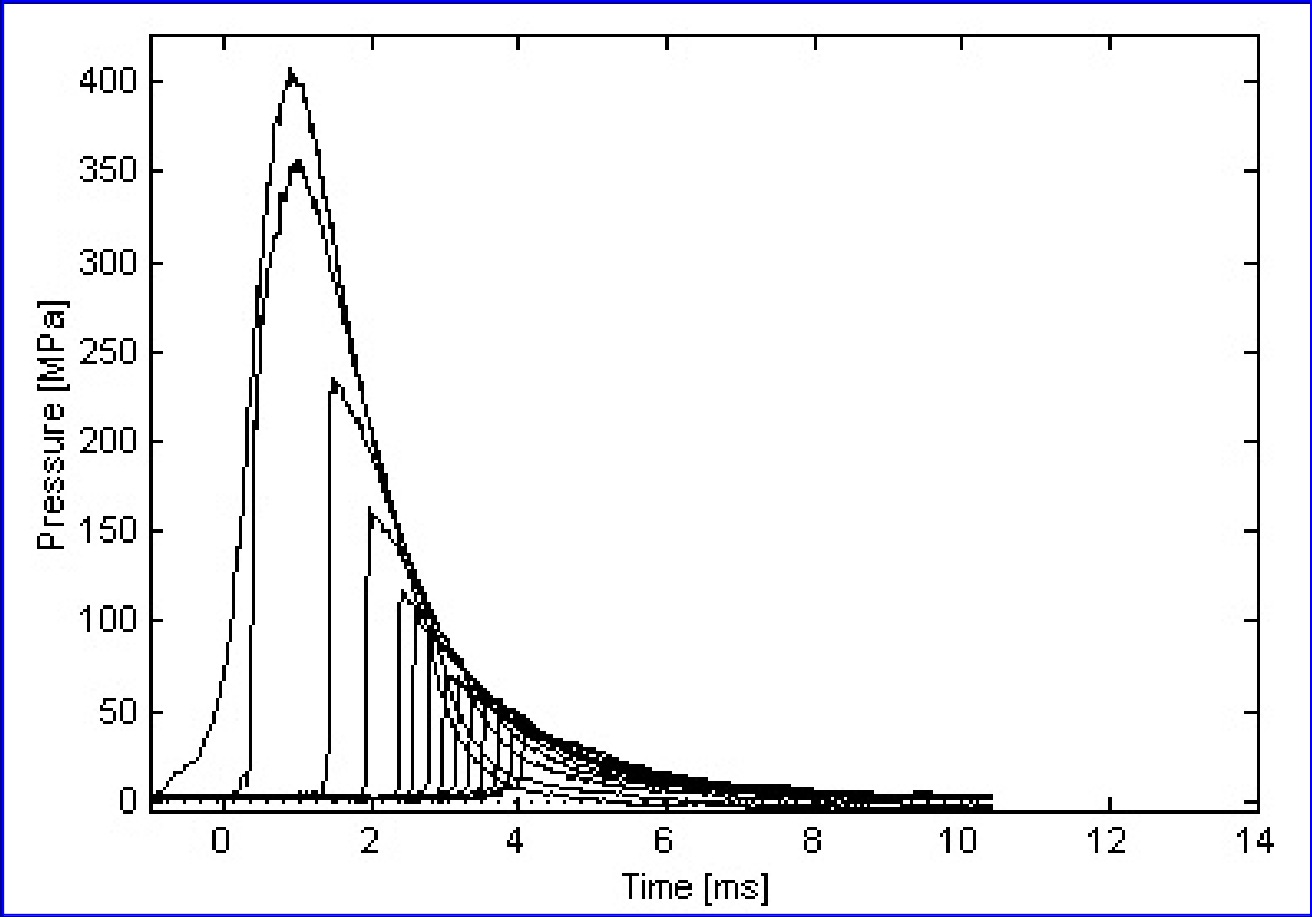

1131 m/s Muzzle Velocity 2-3-5

Superimposed Chamber Pressure

Light-Nominal-RAVEN vs. Non-Venting

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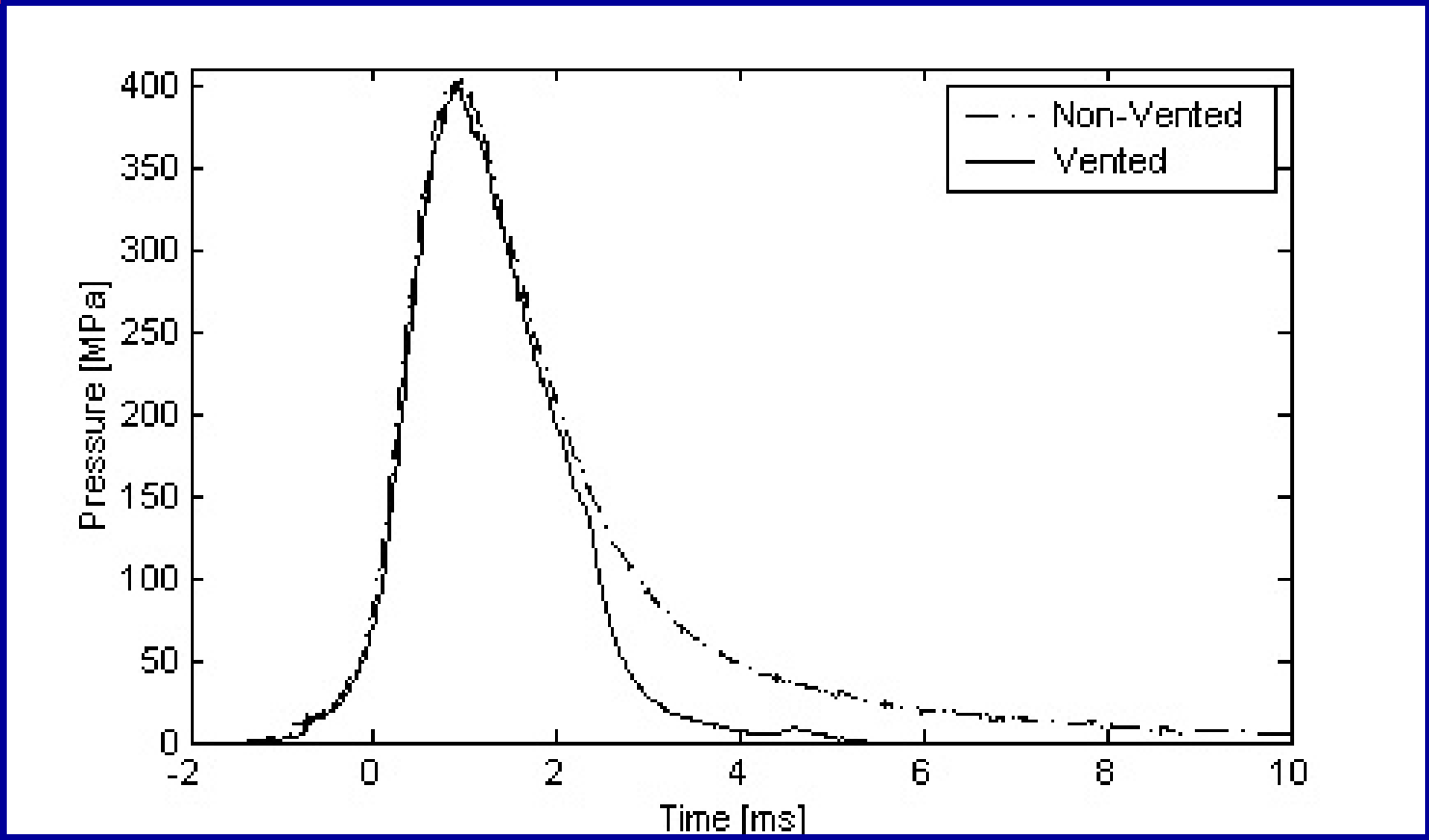

1131m/s Vented vs 1135m/s NV

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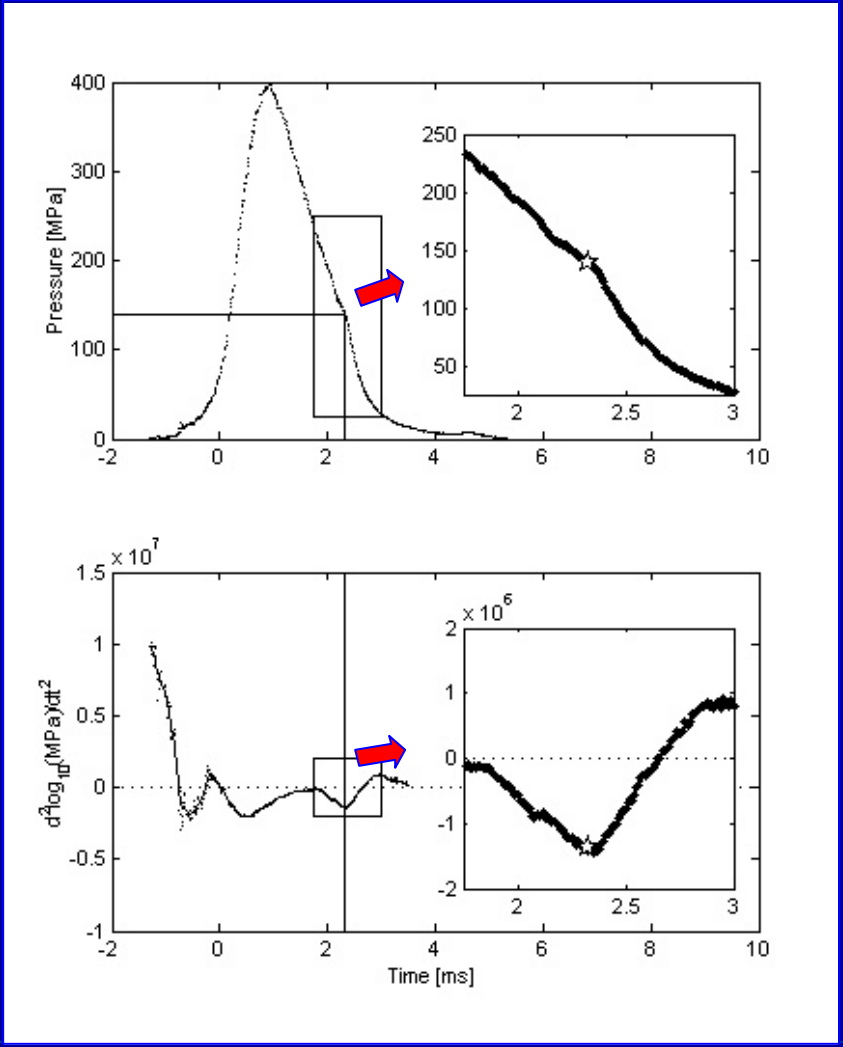
Rarefaction Wave Head Identification



Local Minimum of second derivative of pressure trace is indicative of wave head passage.

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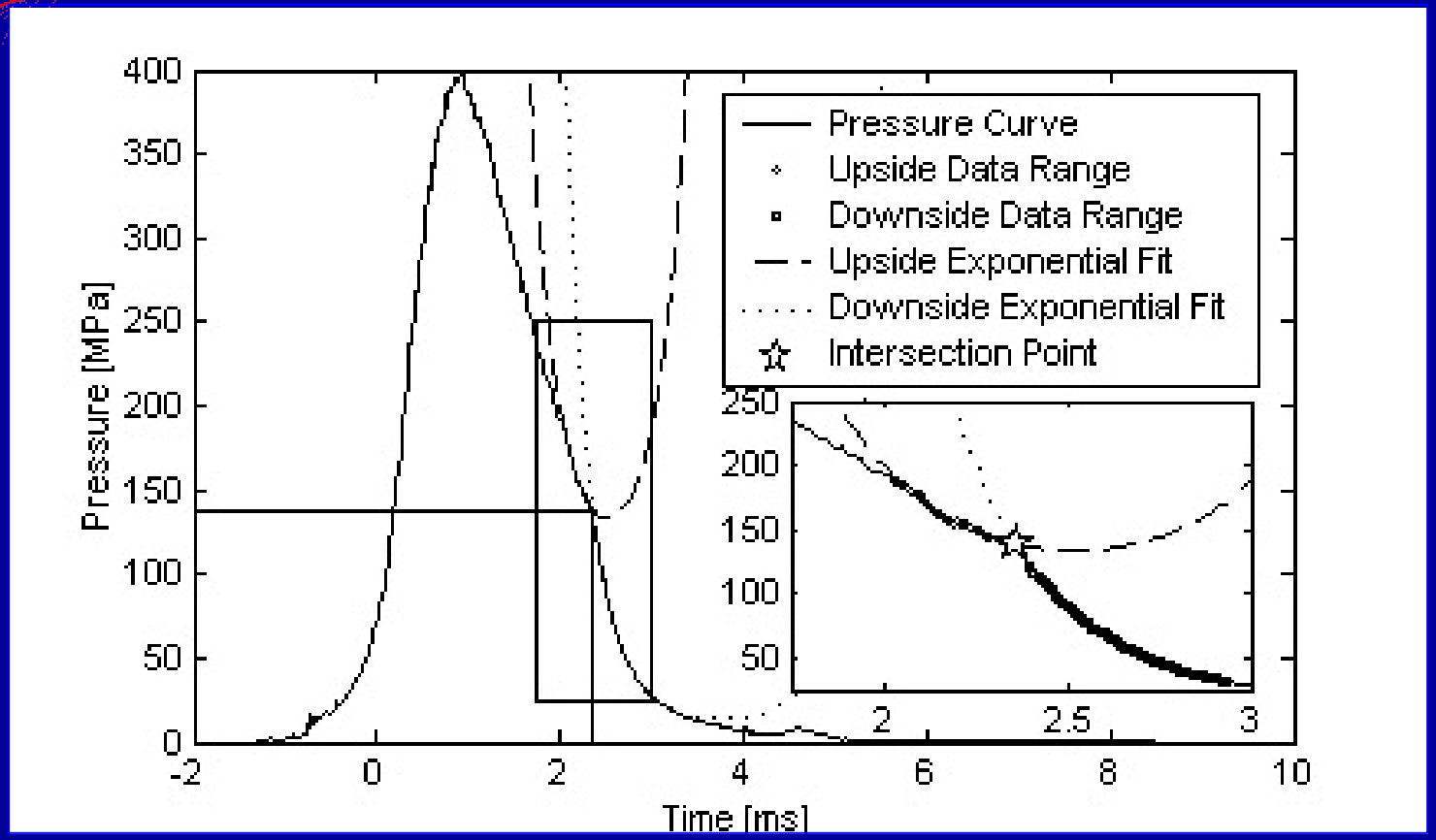
Rarefaction Wave Head Identification



- Intersection of exponential fits avoids sensitivity to smoothing drift.

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Pressure Travel Time Curve

Light-Nominal-RAVEN

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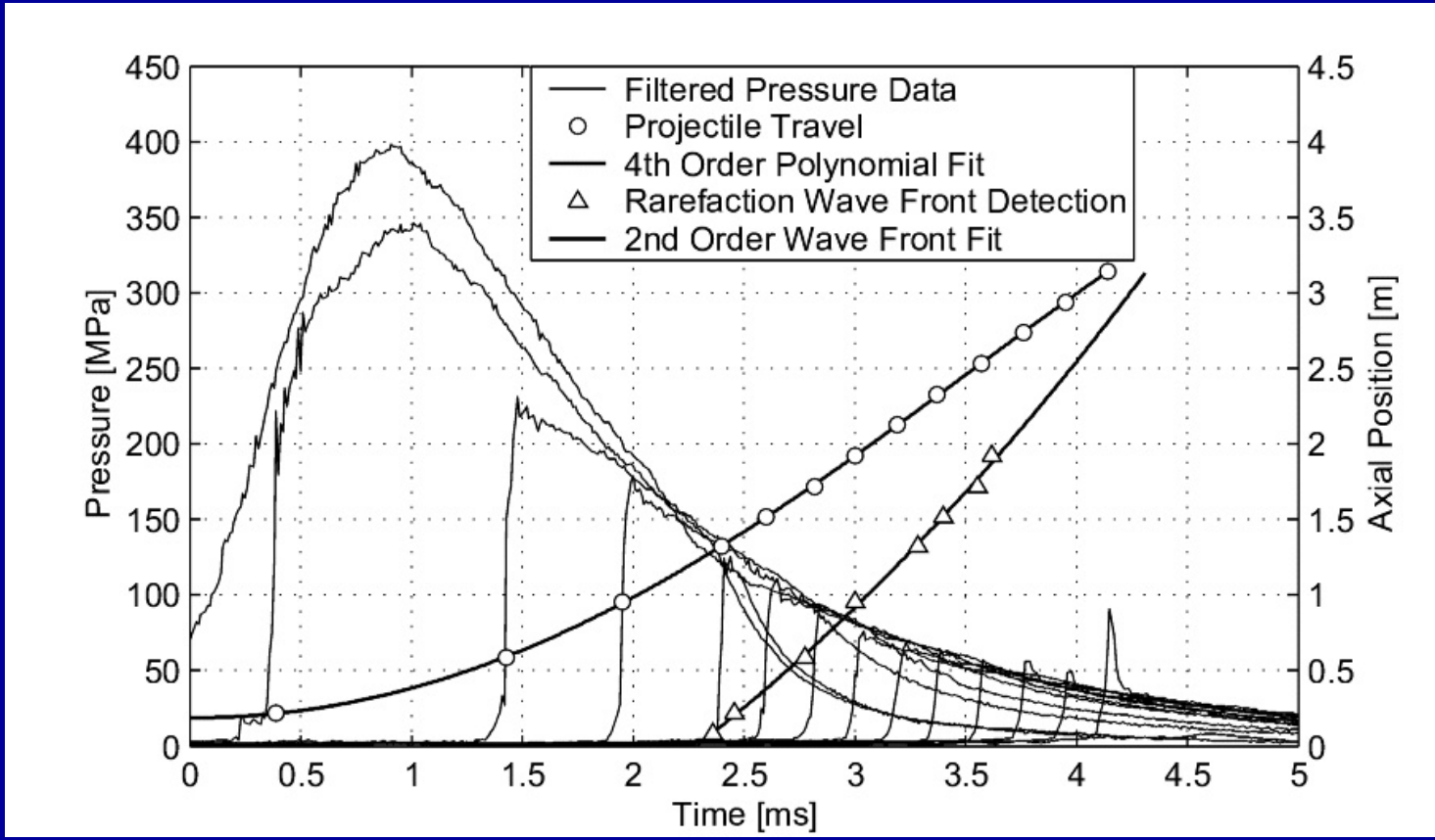

Wave Front Chases Projo Down Bore.

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Superimposed Pressure Gradient

Heavy-Early-RAVEN vs. Non-Venting

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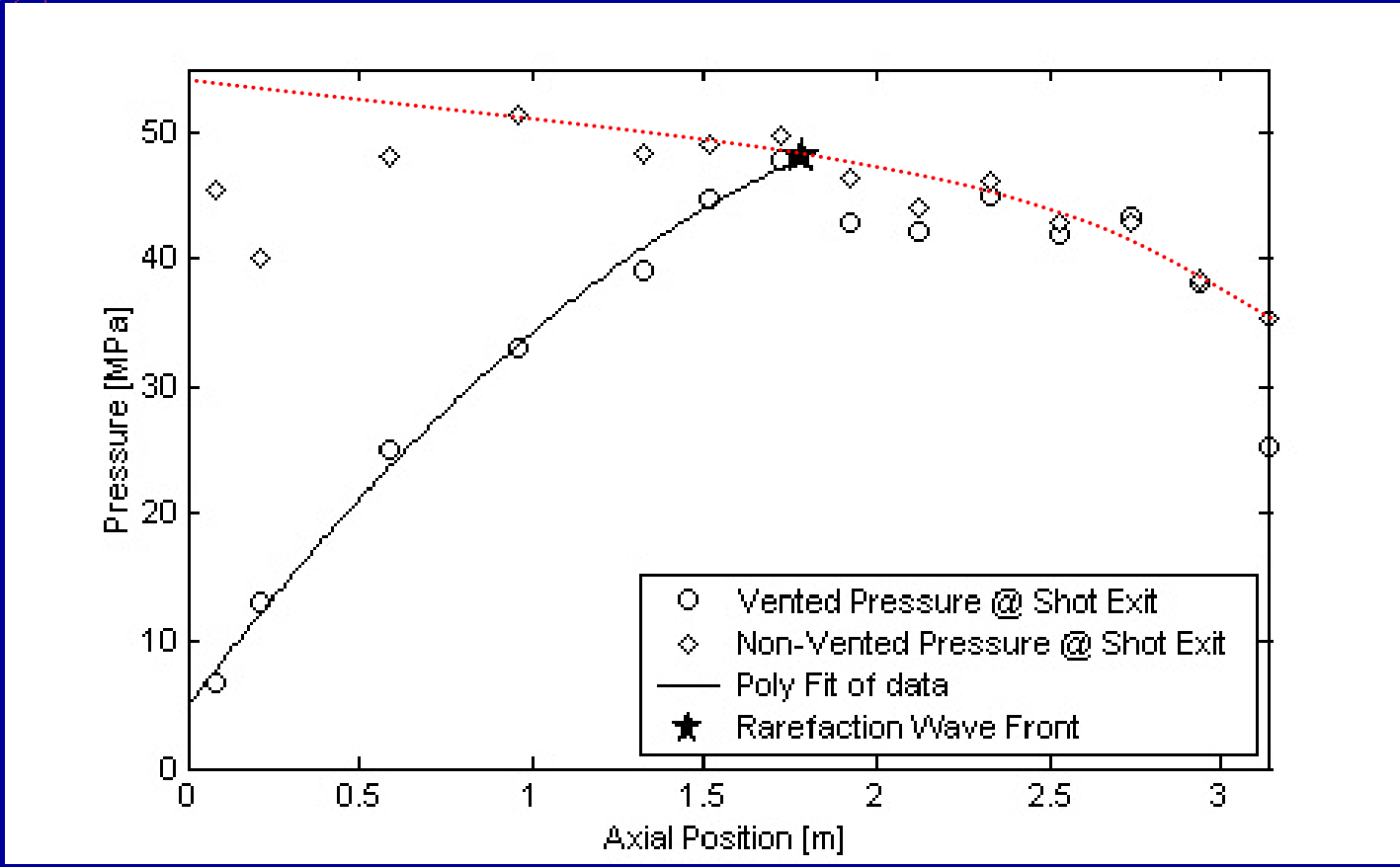

1131m/s Vented vs 1135m/s NV

Superimposed Pressure Gradient

Heavy-Early-RAVEN vs. Non-Venting

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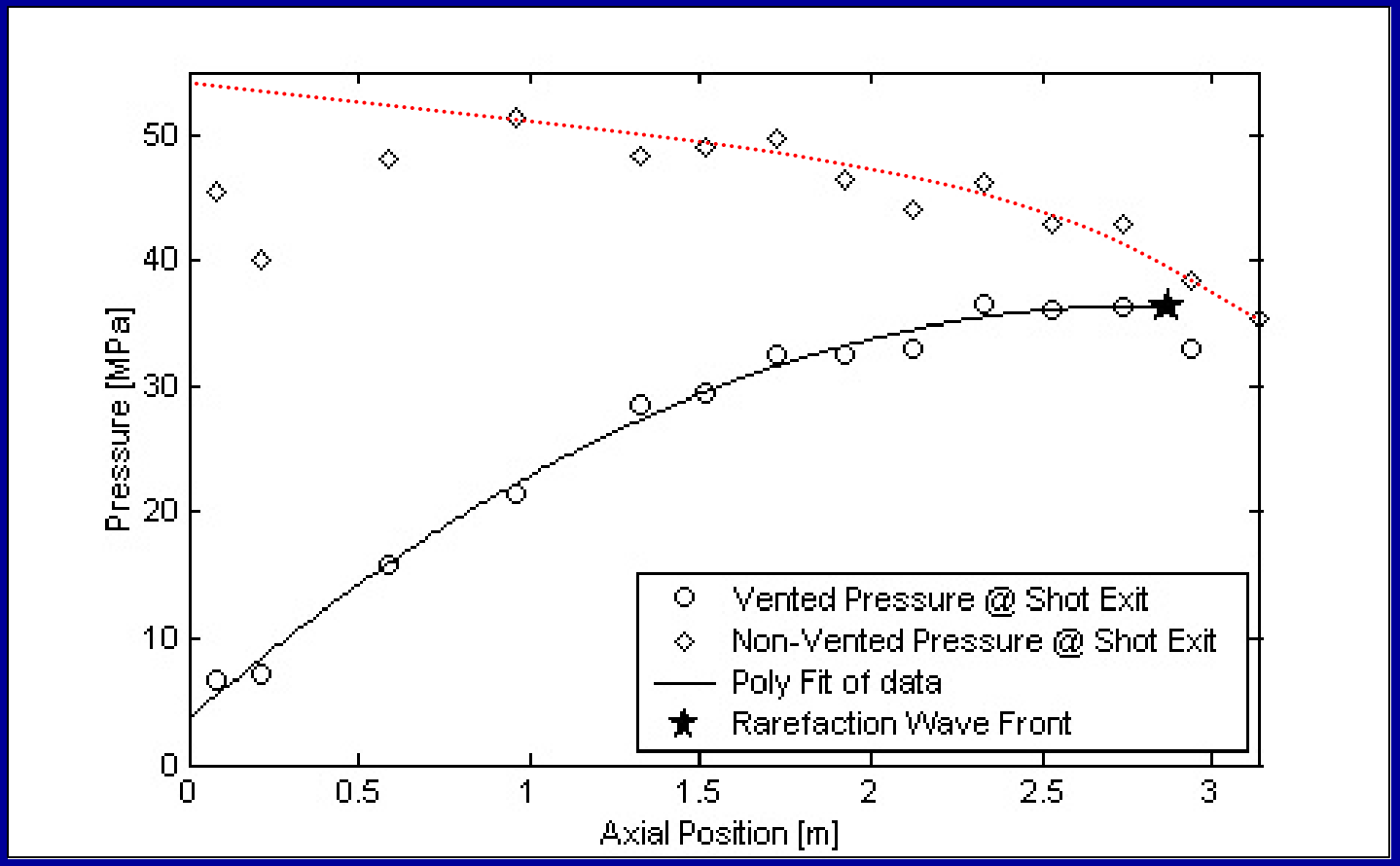

1131m/s Vented vs 1135m/s NV

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Measured Recoil Reduction

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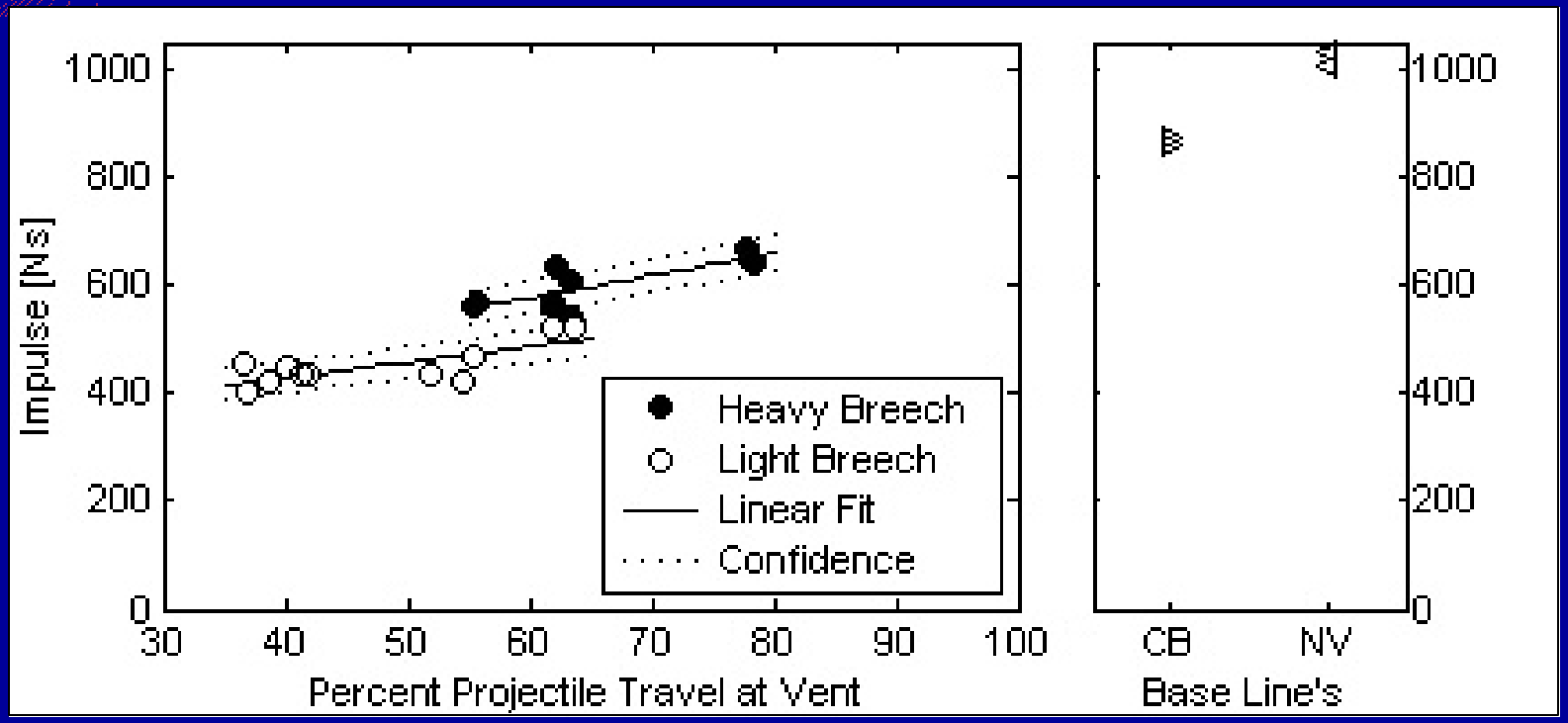

Two Base Lines:

- 51% reduction vs closed breech
- 58% reduction vs inertial breech

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Reduced Heat Transfer

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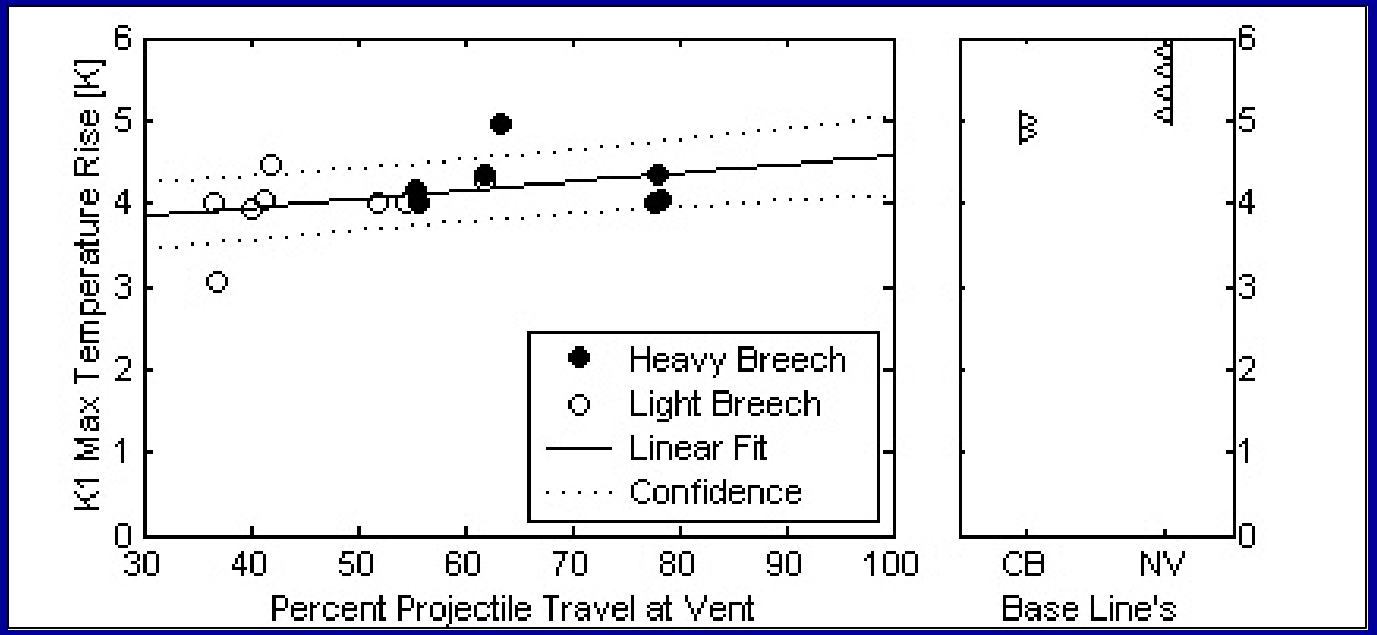

- 20% Reduction in Temperature at Mouth of Chamber

Reduced Heat Transfer

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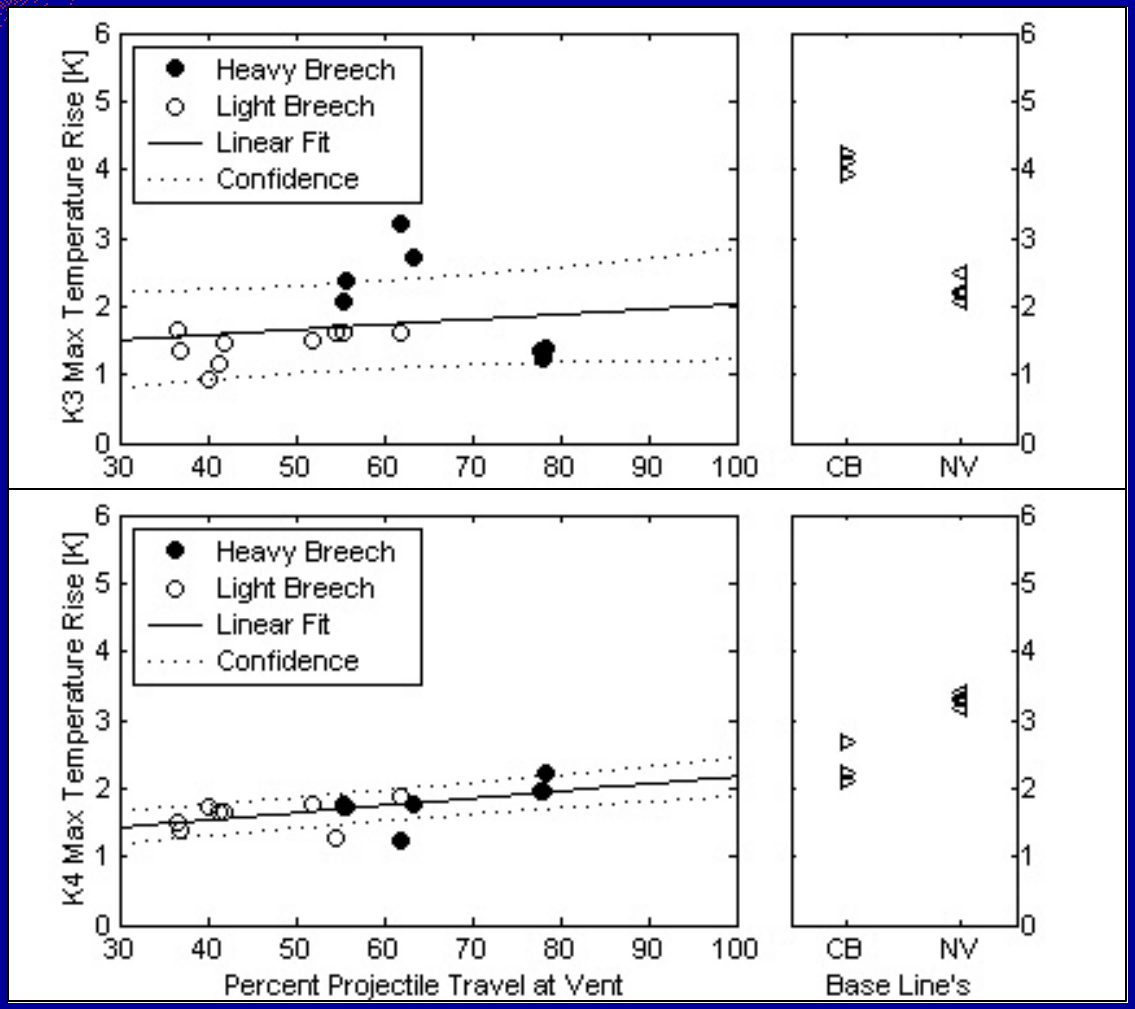

50% Reduction Over Muzzle Half of Barrel

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Muzzle Velocity

- The inertial breech may be anticipated to reduce muzzle velocity due to energy imparted to breech.
- Theoretical (Lumped IB) Vs. Test [m/s]
  - Closed Breech, 1175 vs. 1175 (Matched)
  - Heavy Breech, 1130 vs. 1151
  - Light Breech, 1095 vs. 1100
  - Non Vent Breech, 1124 vs. 1121

CB: 334 Kg, HB: 35.9 Kg, LB: 20.9 Kg, NV: 31.8 Kg

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Comparison to Muzzle Brakes

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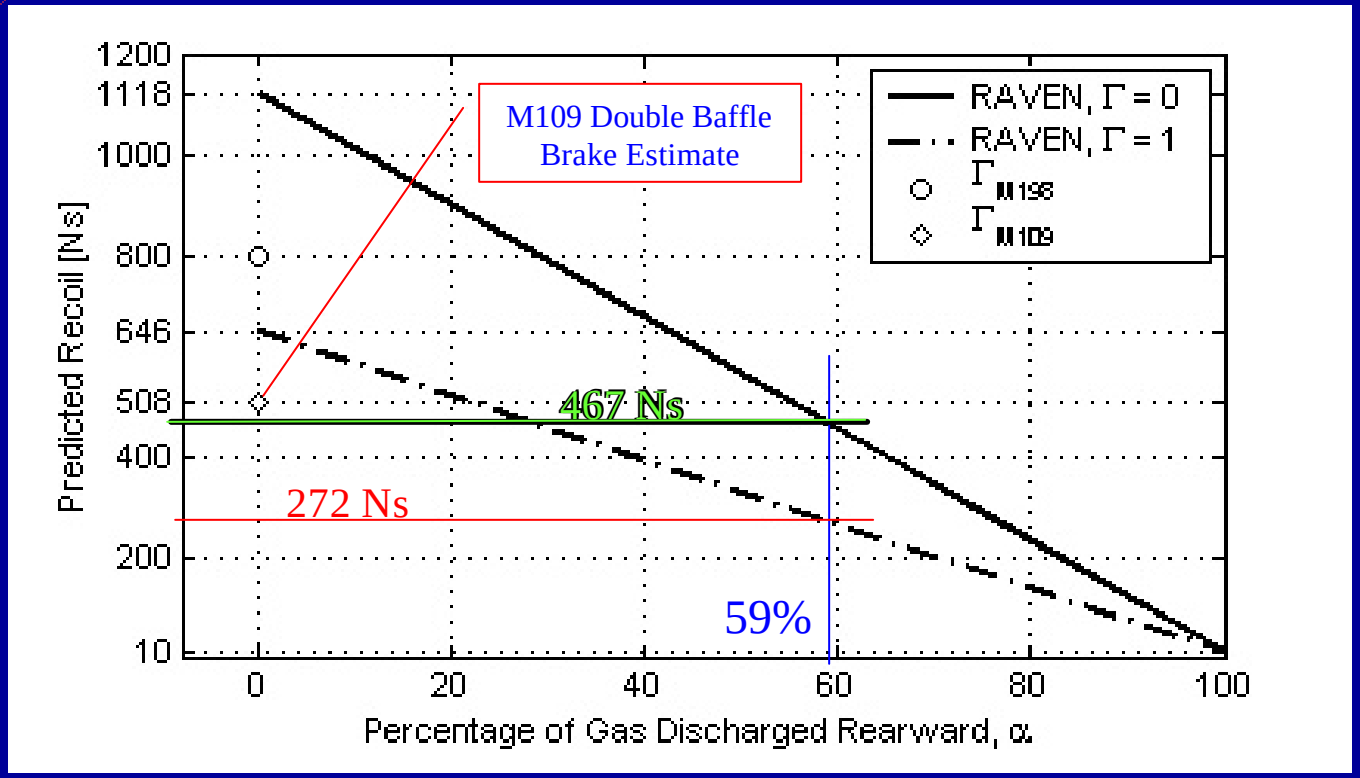

- RAVEN exceeded the performance of a double baffle brake.
- Fitted with a G=1 brake, RAVEN is estimated to nearly halve the remaining M109 momentum.

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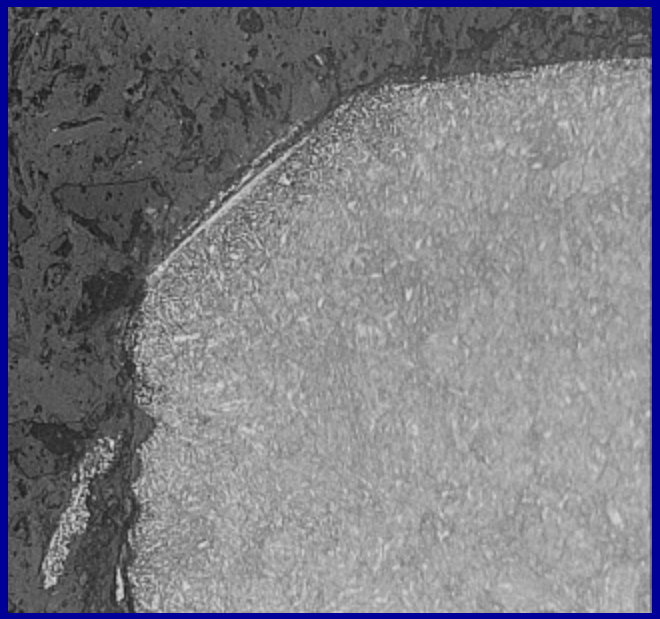
No Nozzle Throat Erosion

- Metallographic analysis of the edge of the “valve seat” indicate a heat affected zone approximately 5 µm deep.



- Zero Erosion Discerned
- Prior concerns regarding erosion may have been overstated.
- Remains to be seen how it will perform with “hot” propellant.

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Potential RAVEN Applications

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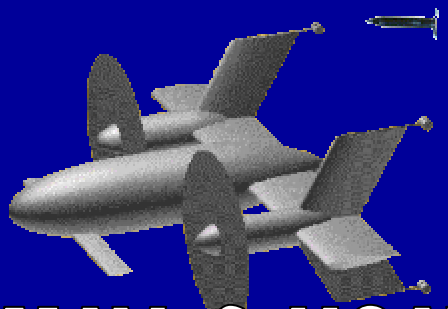

UAV, MAV, & UCAV

FCS

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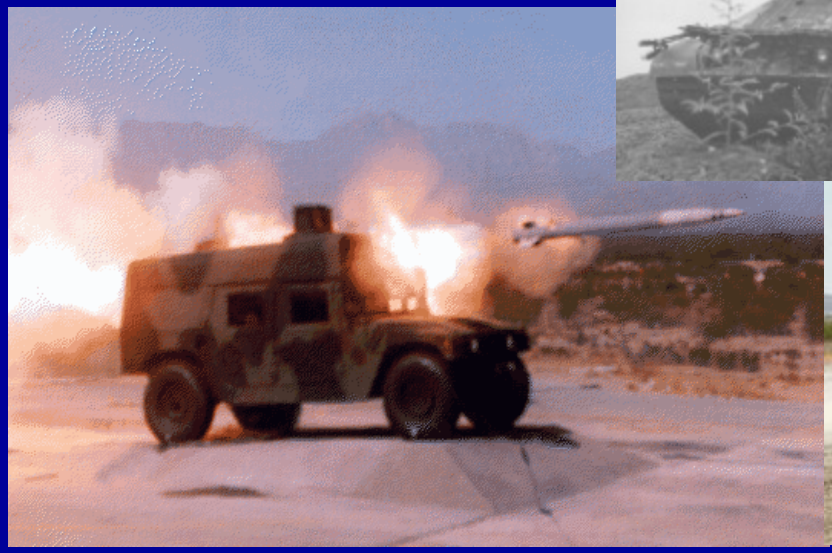
Comments on Back Blast

- Danger zone extent behind prior large caliber recoilless is similar to current TOW missiles.

Source: AMCP 706-238 Recoilless Rifle Weapon systems on 105mm M27 (8 lb_m charge) & FM 23-34 TOW Weapon Systems.



Muzzle Blast

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Gun on a Stick

ELEVATED TOW SYSTEM (ETS)

The mast mounted TOW system developed by Delco in conjunction with Falck-Schmidt of Denmark provides a unique battlefield capability. Chassis mounted, it is a highly mobile, armored TOW platform capable of reconnaissance and engagement from defilade.

Gun on a Wing-Tip

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Advances in composite cannon technology, fire control stabilization, and smart ammunition may work with recoilless operation to provide formidable armament for overwhelming lethality

U.S. P-51 with 106 mm Recoilless Rifle on each wingtip

Conclusions

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- RAVEN concept experimentally validated.
- Dramatic reduction in measured recoil momentum observed w/out compromise in projectile propulsion.
- Substantial reduction in barrel heating observed.

Comments:

- Recoil and Barrel Heating Reduction may prove ***Enabling*** for Future Composite Guns.
- Efficient Recoilless Operation Also Viable.