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STUDIES OF PELLET ACCELERATION WITH ARC DISCHARGE HEATED PROPELLANTS

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INTERNATIONAL PELLET FUELING WORKSHOP

October 30 - November 3, 1985

* Research sponsored by the Office of Fusion Energy, U.S. Department of Energy, under Contract No. DE-AC05-84OR21400 with Martin Marietta Energy Systems, Inc.

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STUDIES OF PELLET ACCELERATION WITH ARC DISCHARGE HEATED PROPELLANTS

D. D. Schuresko
Oak Ridge National Laboratory*

An arc discharge has been utilized to heat gaseous propellants in a pneumatic pellet gun. A cylindrical arc chamber is interposed between the propellant inlet valve and the gun breech and fitted with a ceramic insert for generating swirl in the incoming gas stream. The arc is initiated after the propellant valve opens and the breech pressure starts to rise; a typical discharge lasts 300 microseconds with peak currents up to 2 kA at arc voltages ranging from 100-400 V. The system is instrumented with piezoelectric pressure transducers at the propellant valve outlet, gun breech, and gun muzzle. The gun has been operated with 4 mm diameter polyurethane foam pellets (density = 0.14 g/cm³), a 40 cm-long barrel, and various gas propellants at pressures exceeding 70 bar. At $I_{\text{arc}} = 1$ kA, $V_{\text{arc}} = 200$ V, with helium propellant, the arc produces a 2-3 fold prompt increase in P_{breech} and a delayed increase in P_{muzzle} ; the pellets exit the gun from 0.5-1.0 ms earlier than with the gas alone at 40% higher speeds. Comparisons with the so-called ideal gun theory and with full one-dimensional hydrodynamic calculations of the pellet acceleration will be presented.

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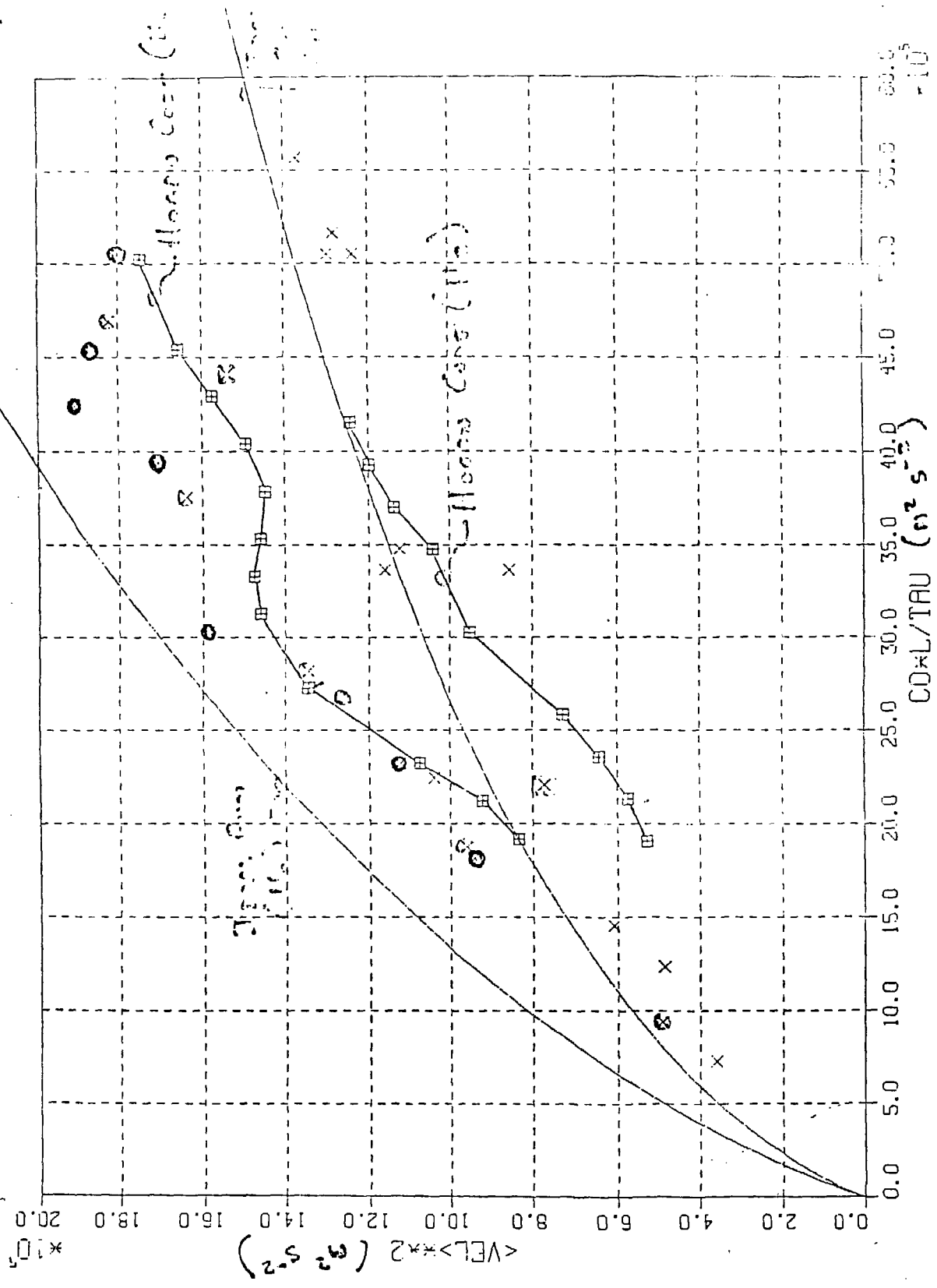
ACCELERATION OF
POLYURETHANE FOAM PELLETS
WITH ARC-DISCHARGE HEATED PROPELLANTS

- 4.2 mm x 4.6 mm diameter polyurethane foam pellets (density - .137 gm/cm³)
- Discharge from 10 kV, 140 μ F capacitor bank
- He, H₂ propellants at pressures of 200 - 1000 psi

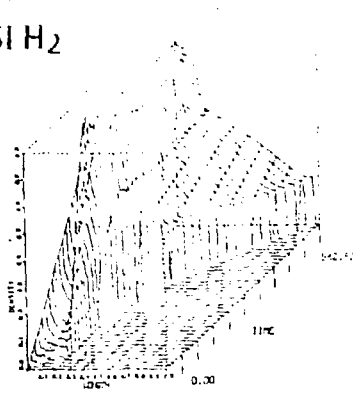
CASE CASE: SIMPLE GEOMETRY, NO. RC

PELLET <VEL> **2 VS. CO * L / TAU

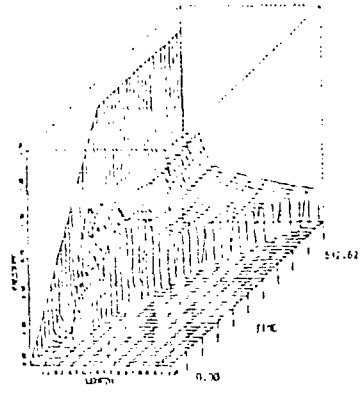
- POLY-U (H₂ GAS)
- × POLY-U (H GAS)
- ⊗ RPI - D₂
- ⊗ RPI - H₂



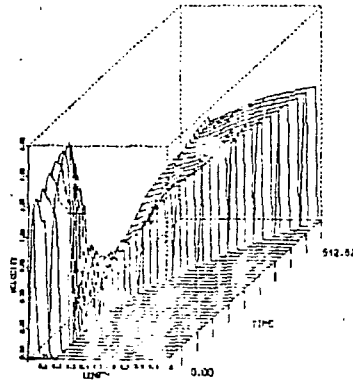
725 PSI H₂



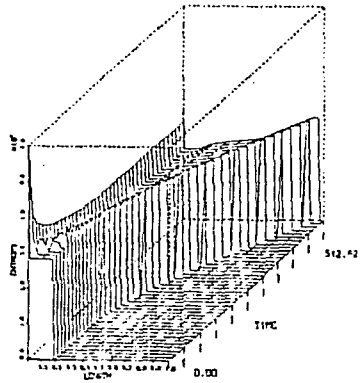
VELOCITY



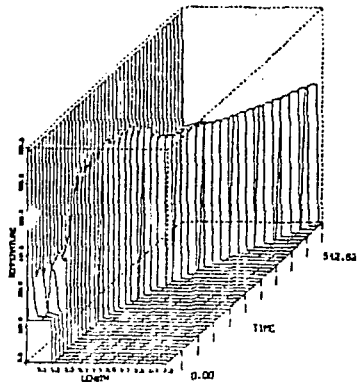
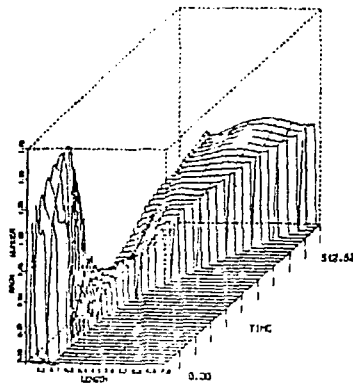
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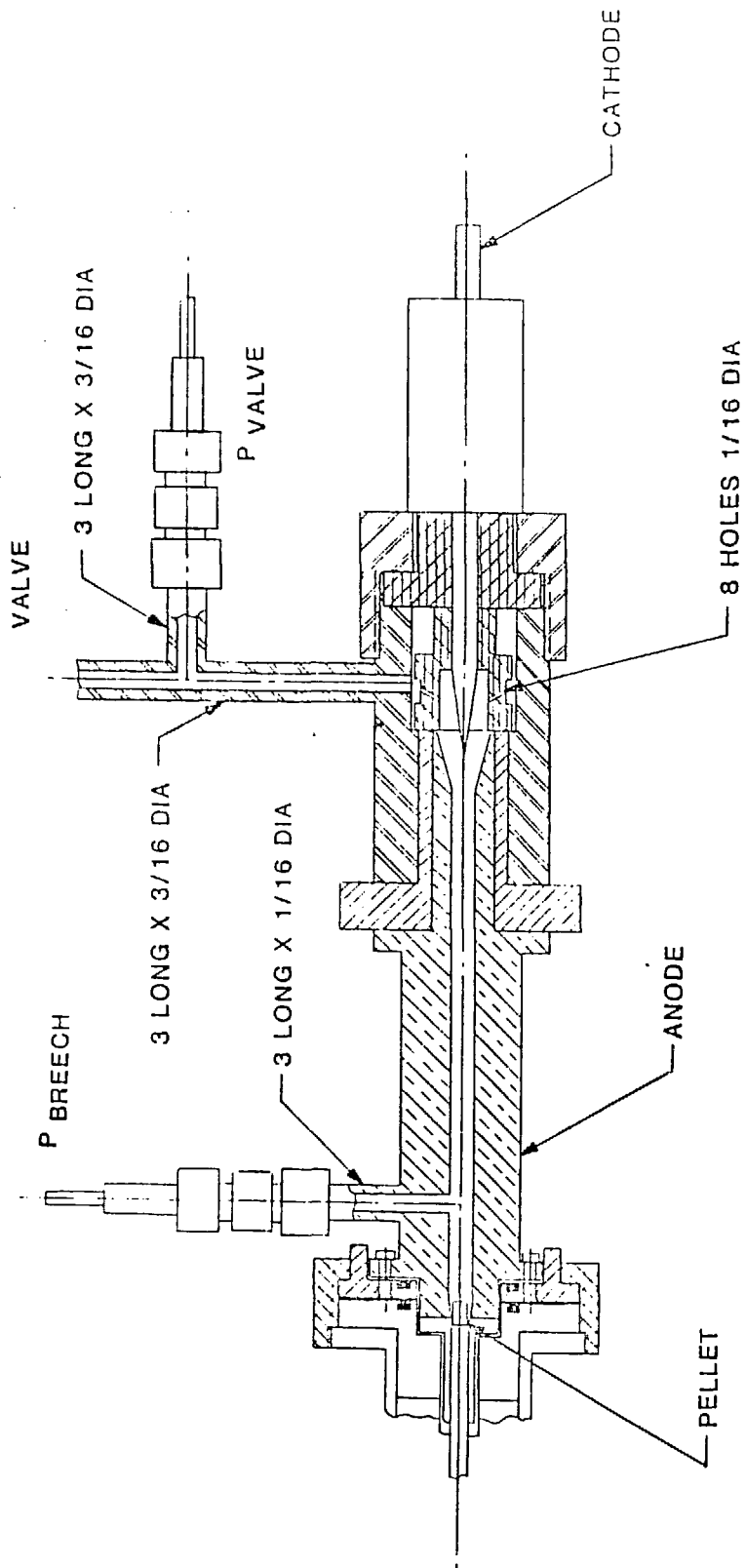


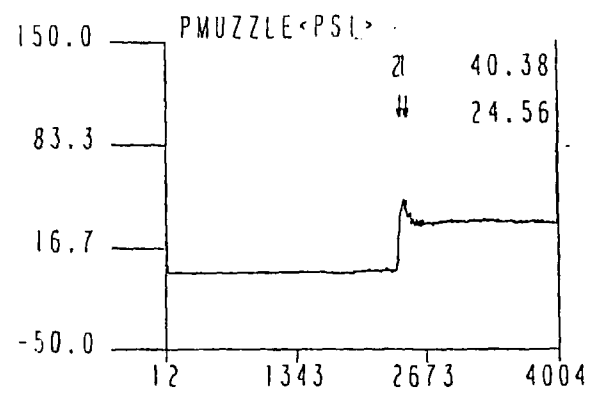
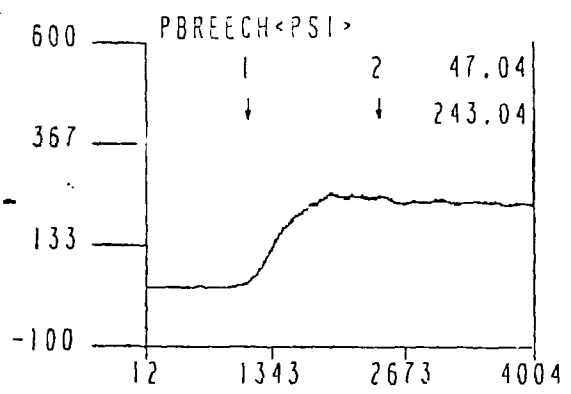
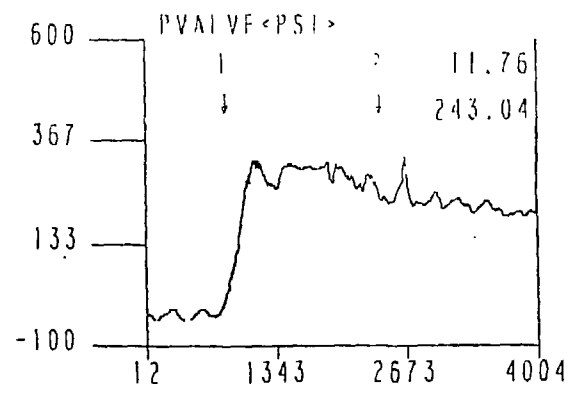
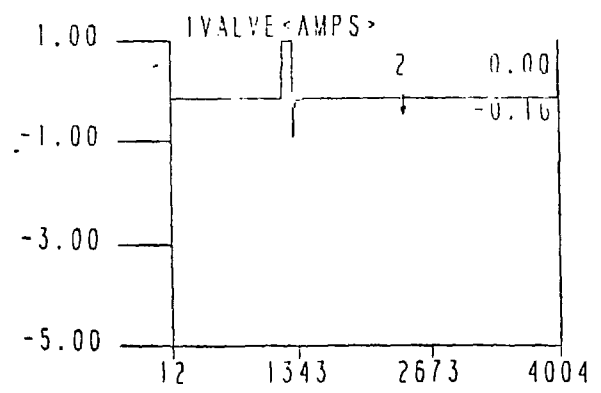
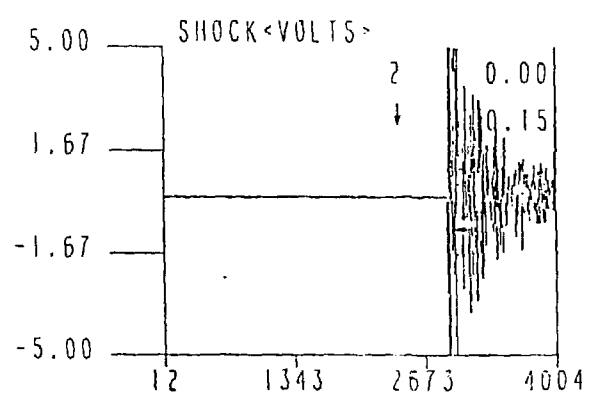
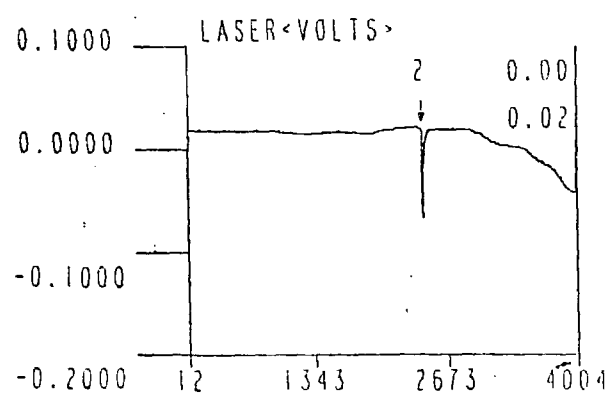
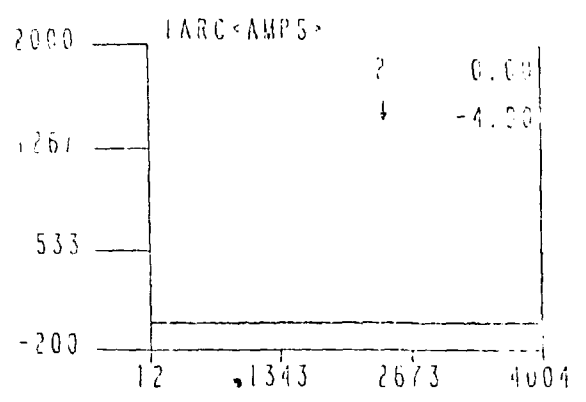
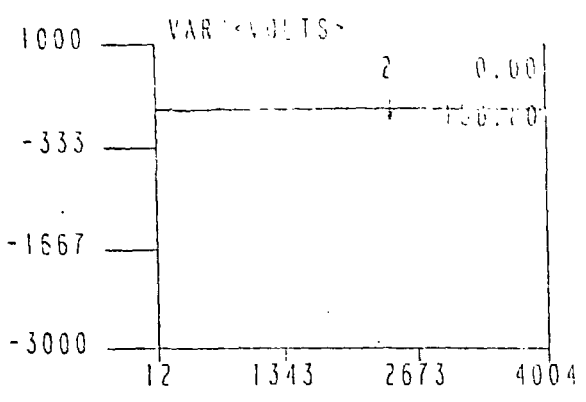
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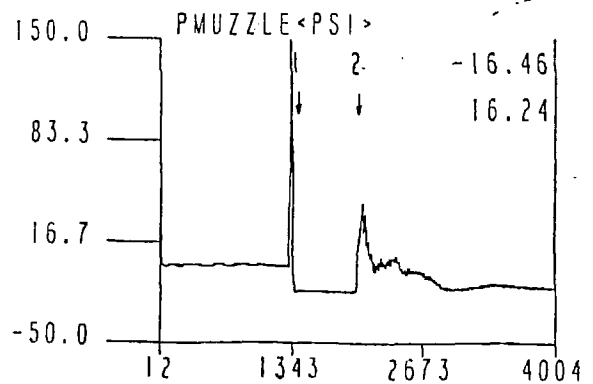
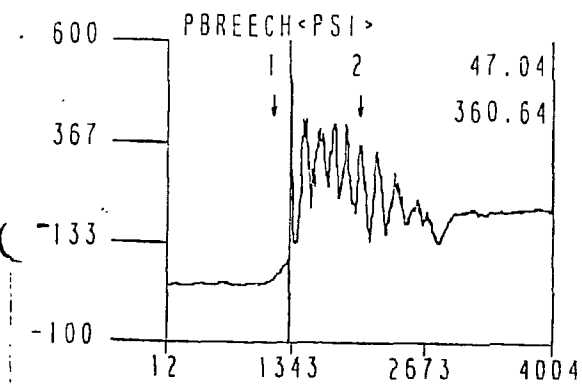
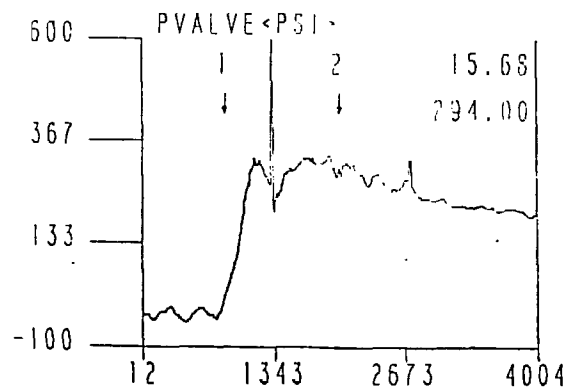
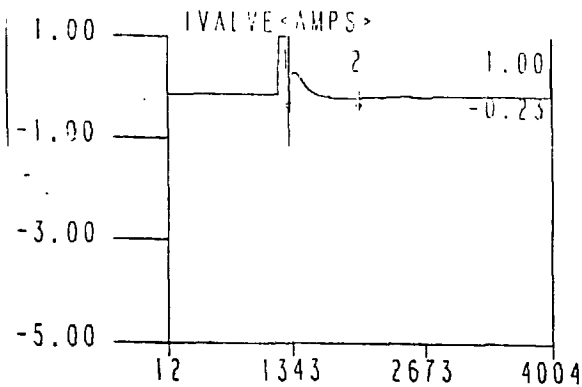
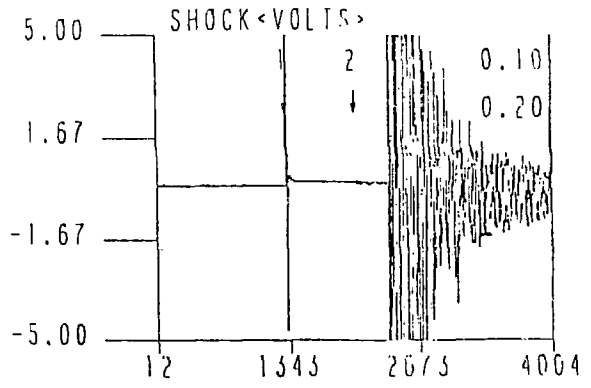
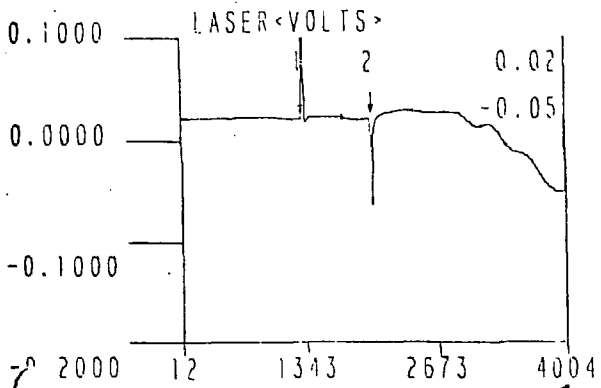
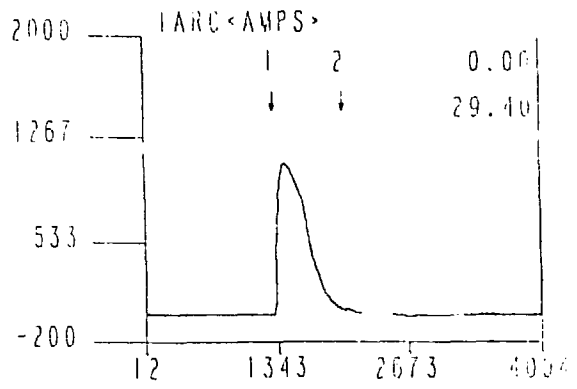
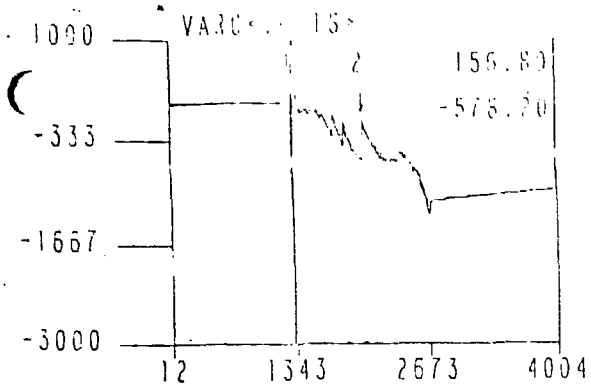


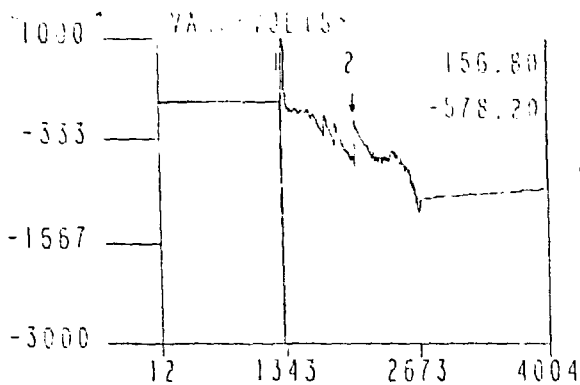
TEMPERATURE



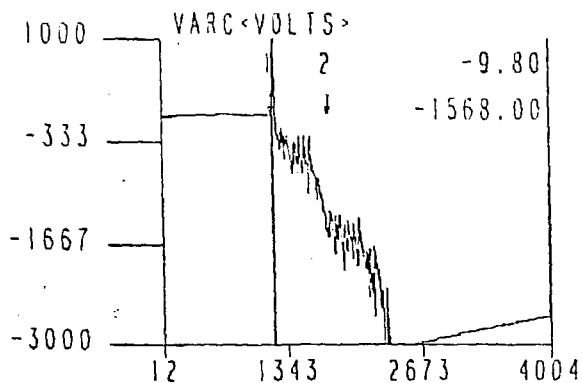
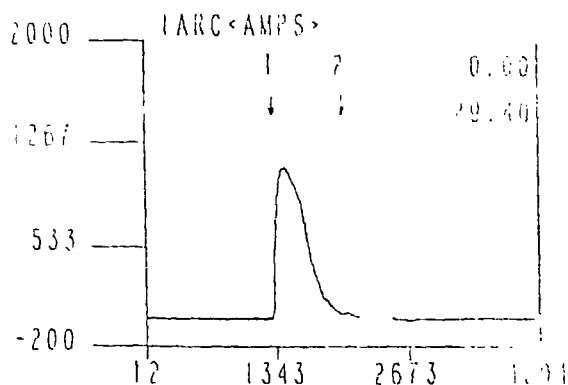




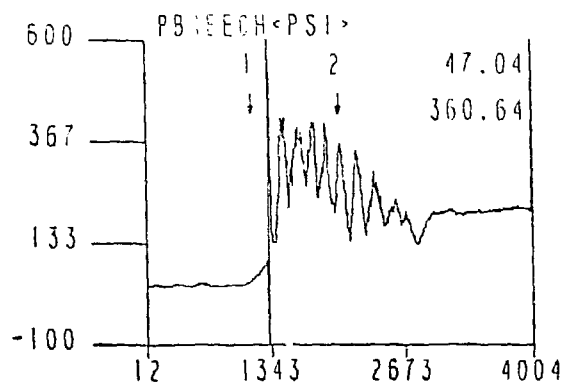
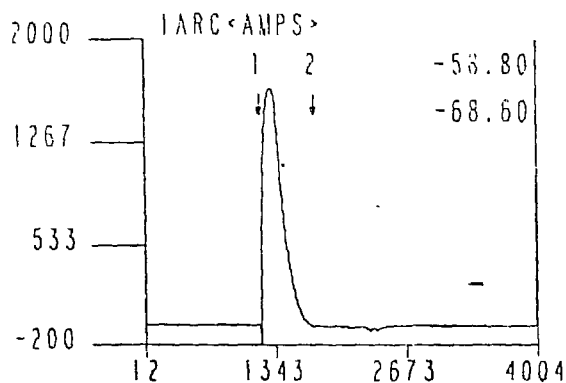




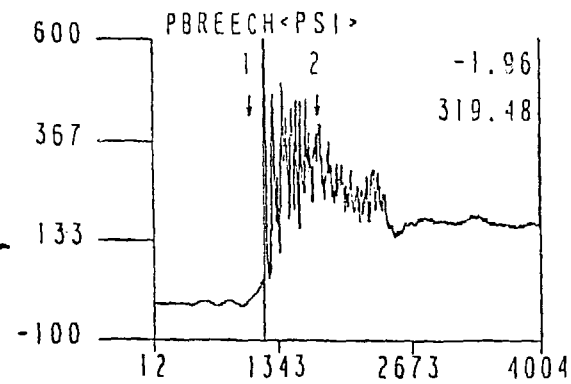
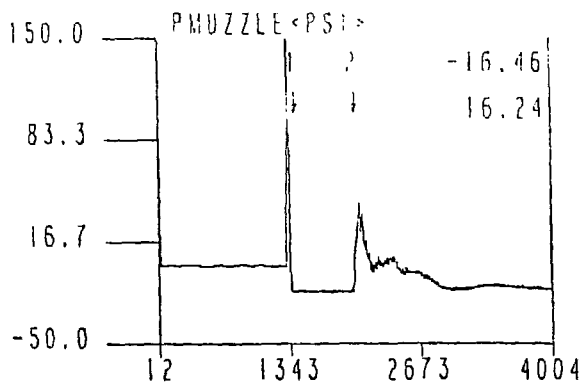
He



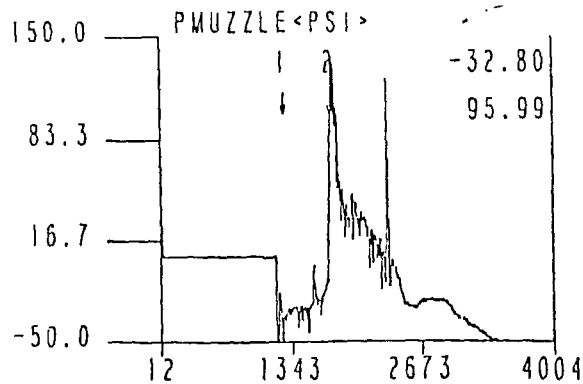
H₂



He



H₂



H₂

SHOT	$\langle P_{Be} \rangle$	ΔP_M	ΔQ^{Arc}	V	K.E.	$\langle P_{Be} \rangle AL = W$	$\Delta P_M / \langle P_{Be} \rangle$	K.E./W
092703	173	—	0	1060	4.9	6.3	—	0.78
092706	259	—	0	1306	7.5	9.4	—	0.80
101510	262	143	110	1387	8.4	9.5	0.55	0.88
101512	202	93	0	878	3.4	7.3	0.46	0.47

He

092002	136	—	0	781	2.7	4.9	—	0.55
092002	270	—	0	1112	5.4	9.8	—	0.55
101107	212	53	47	1075	5.1	7.7	0.27	0.66
101106	148	40	0	759	2.5	5.4	0.27	0.46

~ 5% EFFICIENCY FOR ARC HEATING

CONCLUSIONS

- Polyurethane pellets good surrogates for D₂
- Higher speeds at lower breech pressures with arc

NEXT EFFORTS

- Longer barrels
- B_z arc stabilization
- Ablatable arc cell liners