

ry Industries Ltd. (IMI)



Heavy Ammunition Division



THE APPENDIX

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OUTLINE

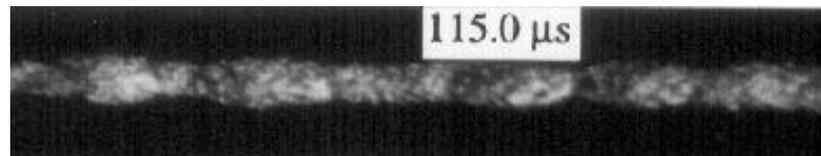
- INTRODUCTION
- EXPERIMENTAL RESULTS
- NUMERICAL MODELLING
- DISCUSSION

INTRODUCTION

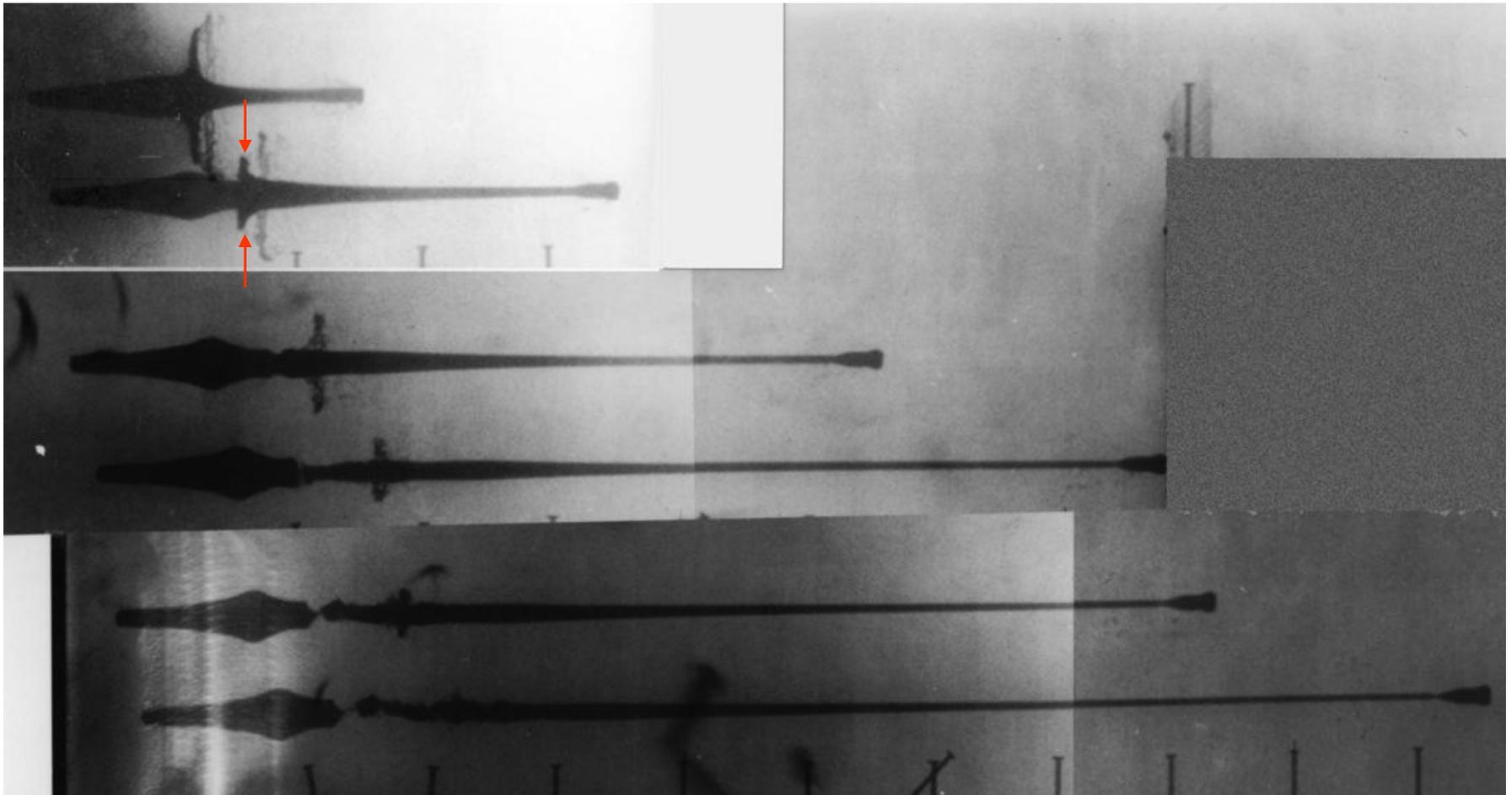
CLASSICAL PARTITION OF THE JET :

MAIN (coherent) JET

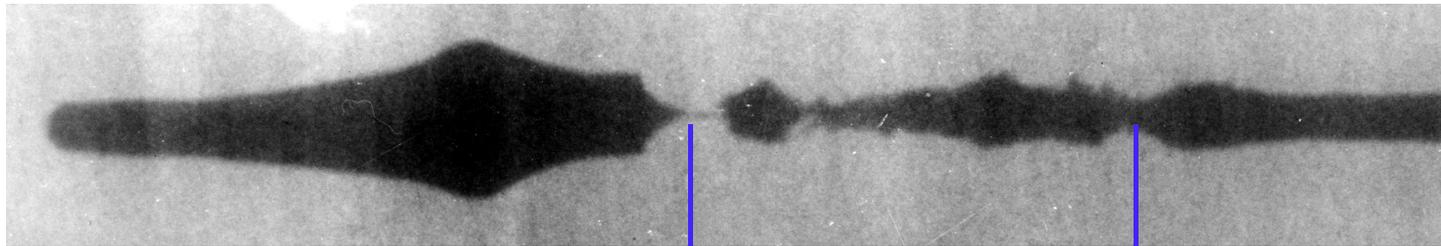
SLUG



BUT IF WE LOOK CLOSER:

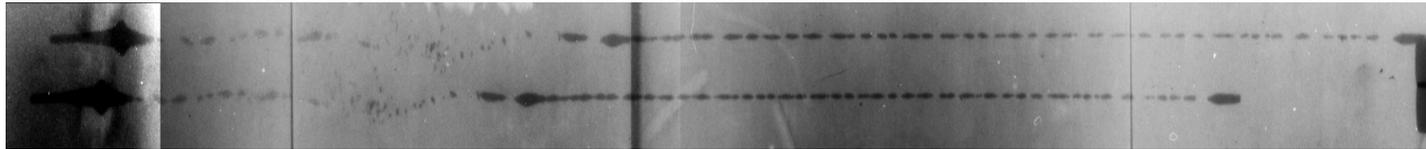


AND YET CLOSER:

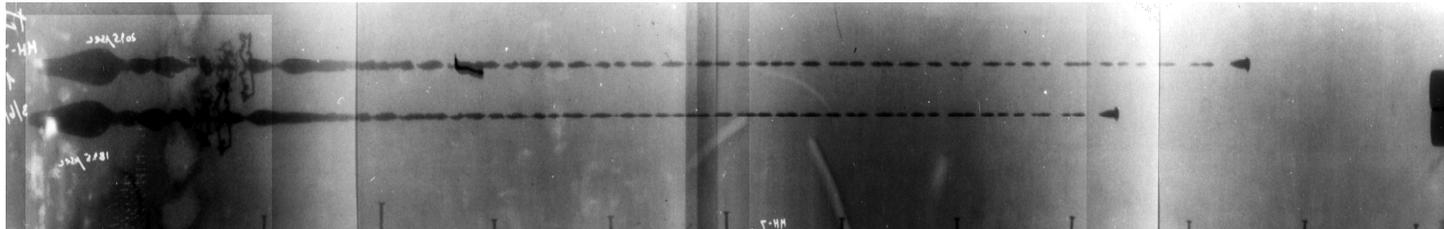


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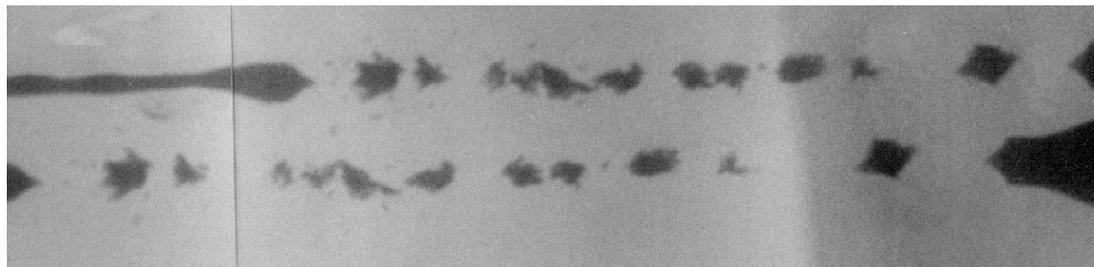
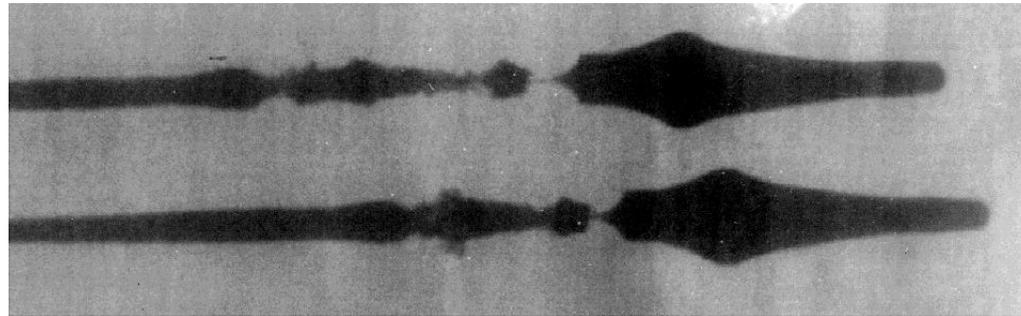
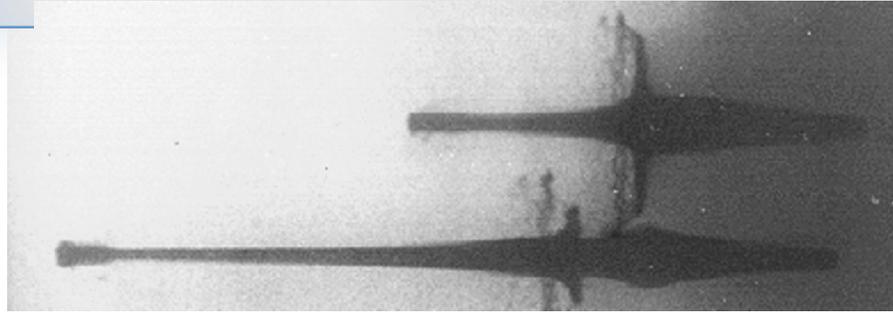
EXPERIMENTAL RESULTS



1% CD LINER



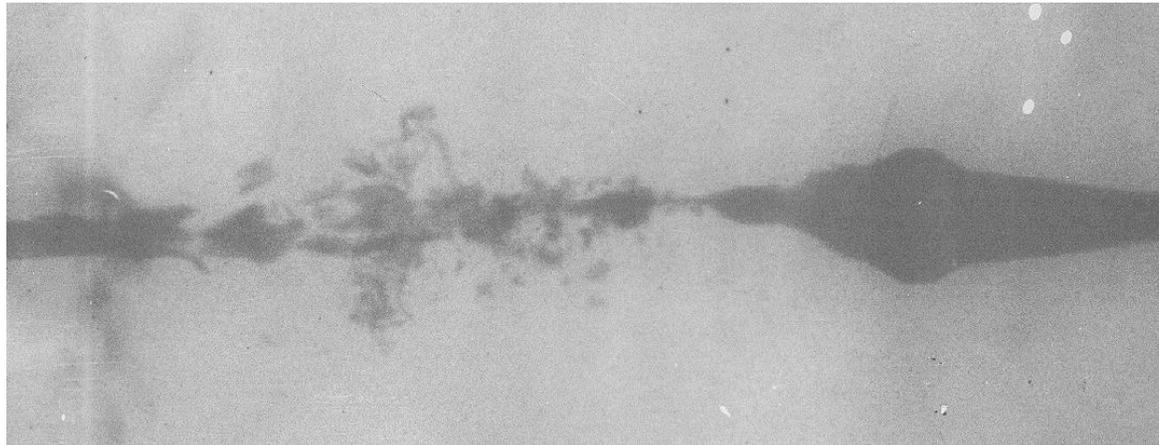
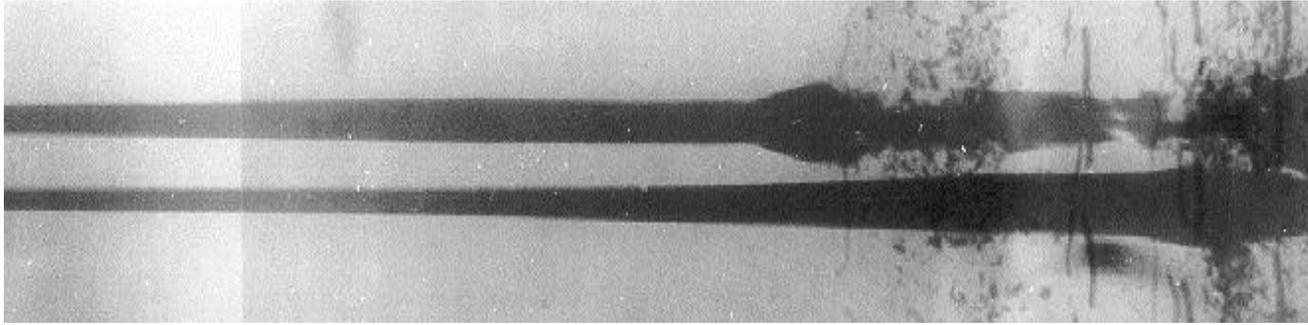
4% CD LINER



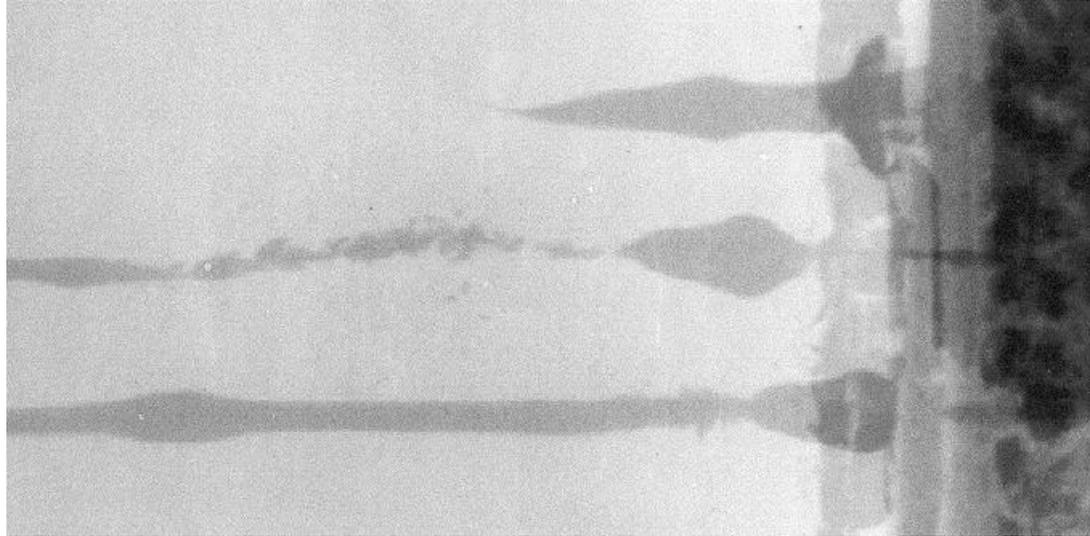
POINT INITIATED UNCONFINED



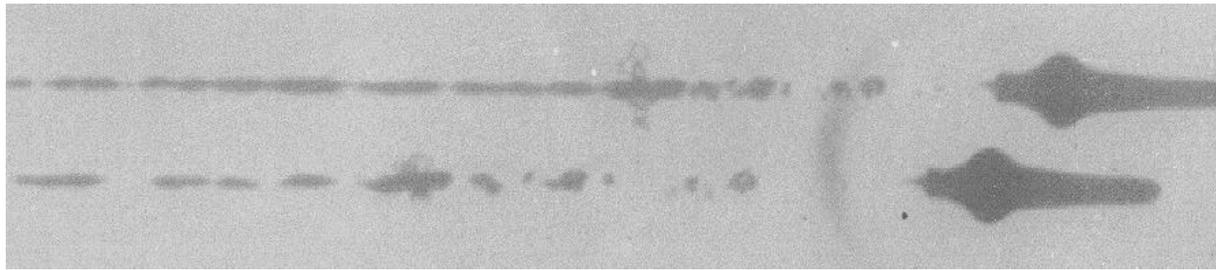
CHARGE AT 30 μ S, 45 μ S, 90 μ S, 100 μ S, 180 μ S & 200 μ S



PERIPHERALLY INITIATED CHARGES



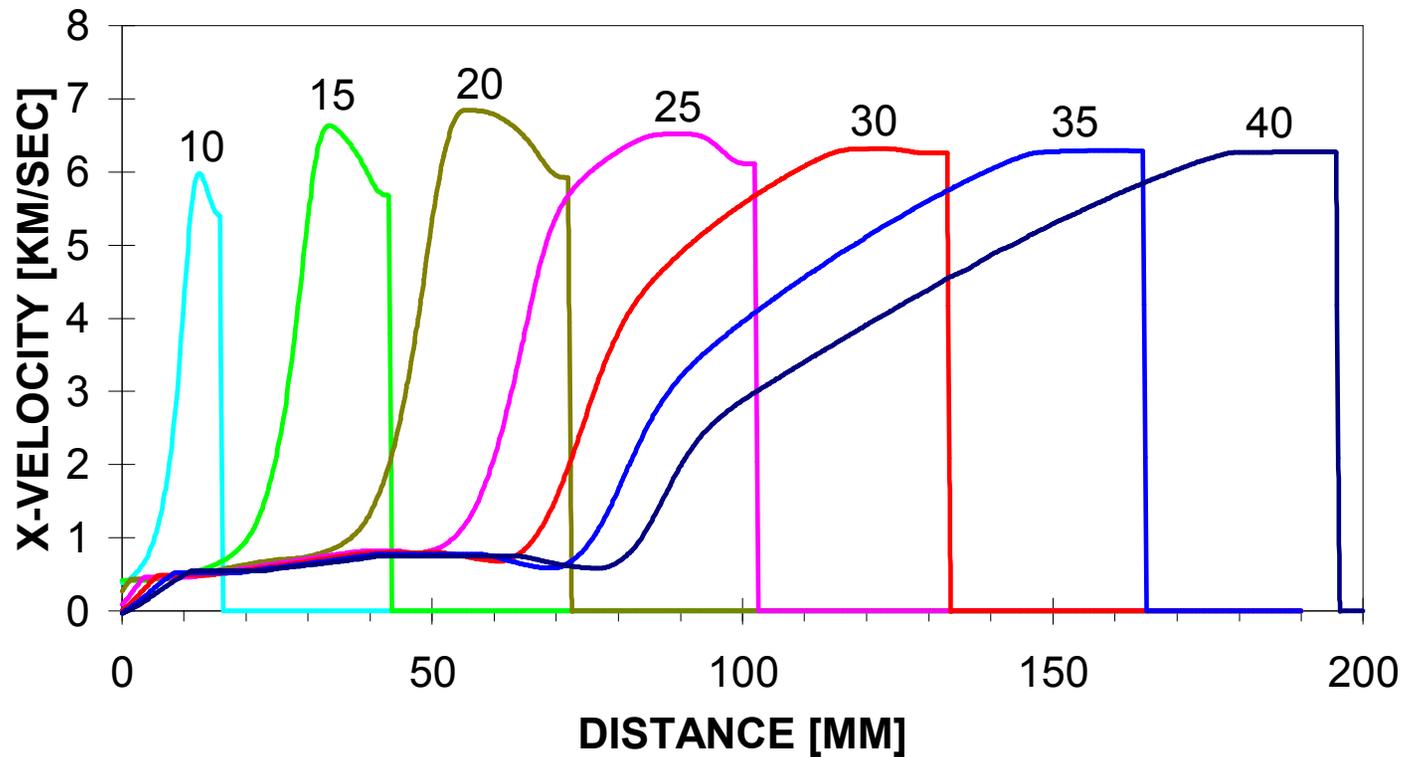
HEAVILY CONFINED HEMISPHERICAL CHARGE AT $30\mu\text{S}$, $50\mu\text{S}$ AND $80\mu\text{S}$



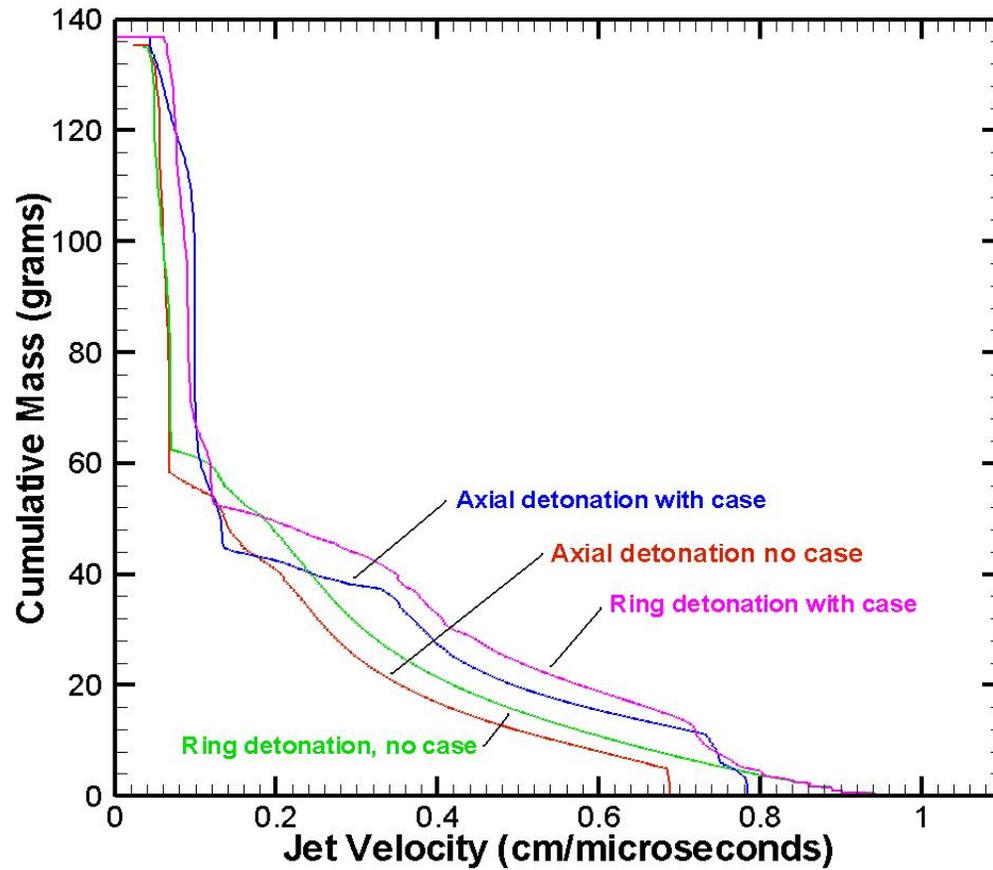
SMALL CHARGE AT 30 μ S AND 50 μ S

SIMULATED VELOCITY PROFILES

FOR P.I. 2% CD LINER THICKNESS



Mass Summation vs. Velocity (t=45)



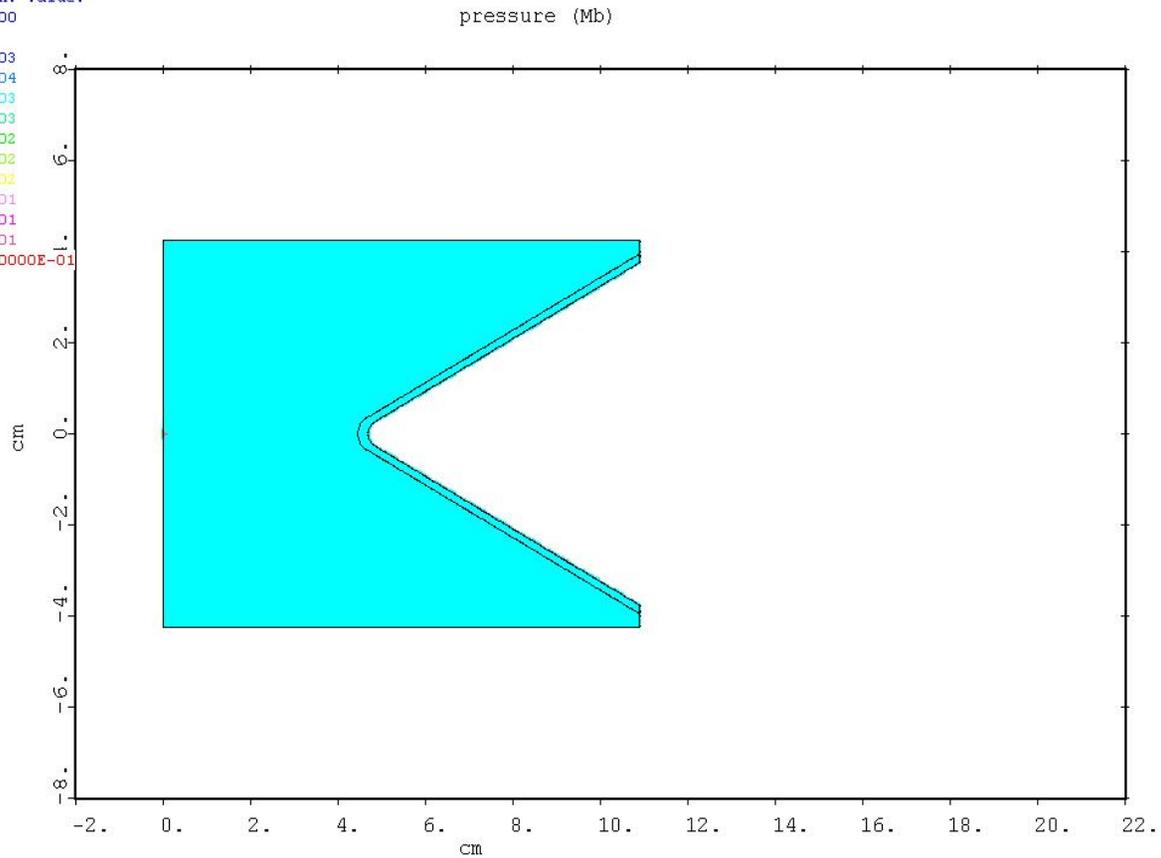
GOALS

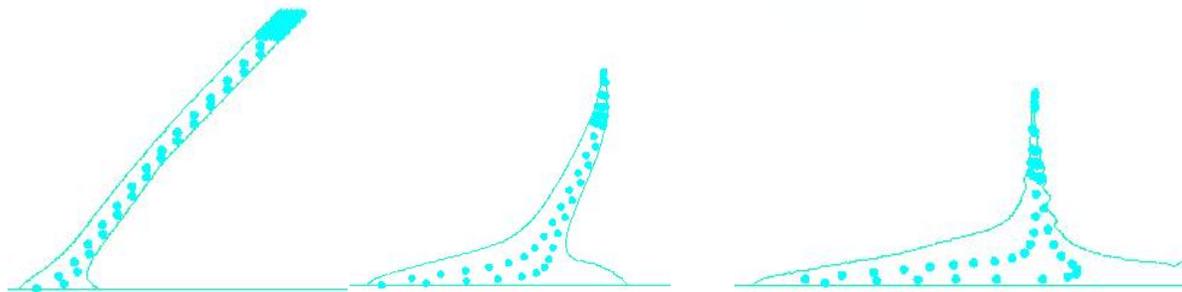
IDENTIFY THE APPENDIX

CHARACTERIZING THE APPENDIX

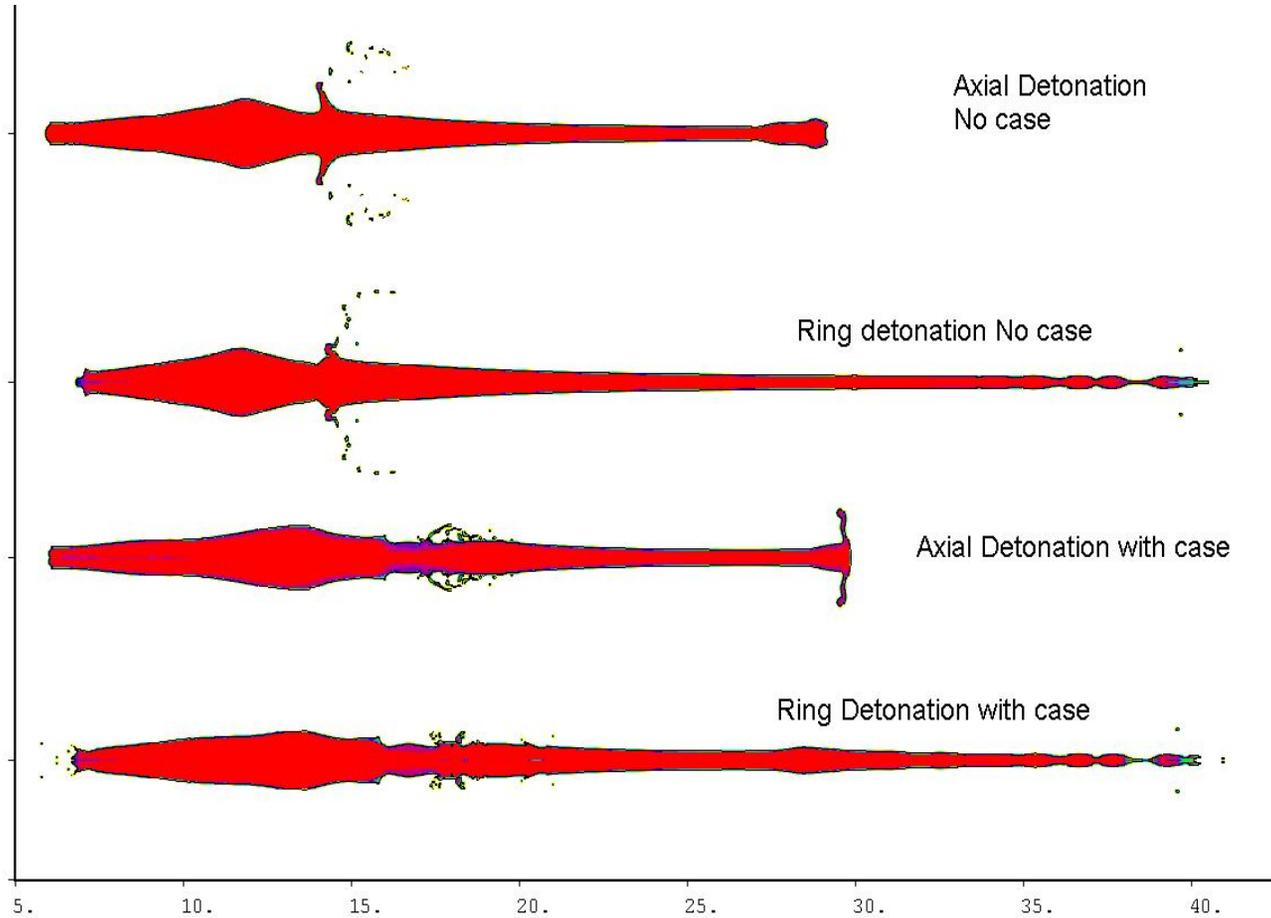
Point initiated charge

```
base line no case r=0 initiation  
time = 1.0789E-01  
global max. value:  
1.1765E-01  
global min. value:  
0.0000E+00  
values:  
-1.0000E-03  
-5.0000E-04  
1.0000E-03  
3.0000E-03  
1.0000E-02  
3.0000E-02  
6.0000E-02  
1.0000E-01  
1.5000E-01  
2.0000E-01  
above 2.0000E-01  
PRESSURE
```

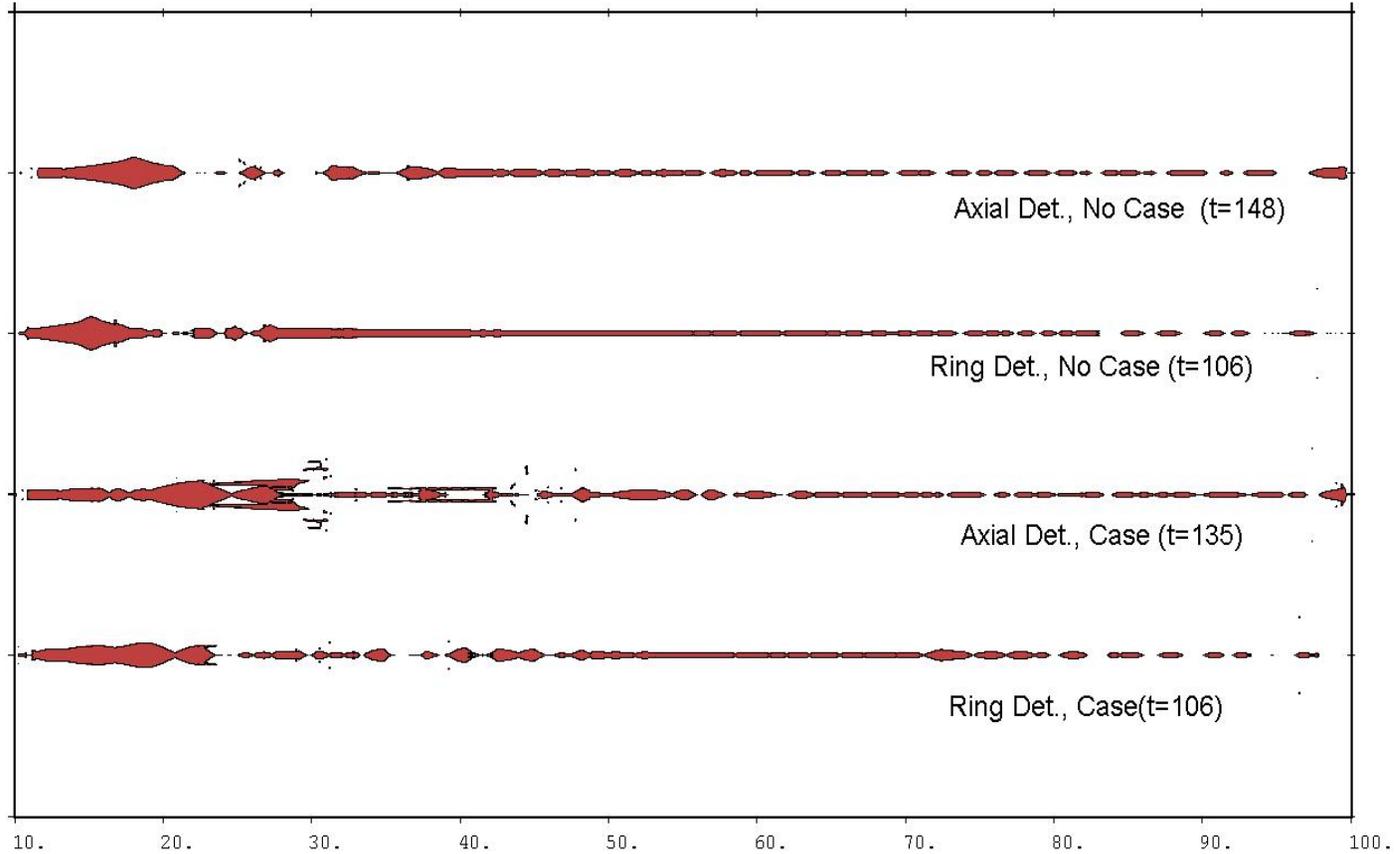




Numerical simulation results of a flow of the liner material points
in a point initiated confined charge
at 10 μs (left), 20 μs (center) and 30 μs (right), after initiation.



Tips are at approximately 90 cm from charge end.



SCAN CALCULATION FOR 1%, 2%, 4% CD LINER THICKNESS

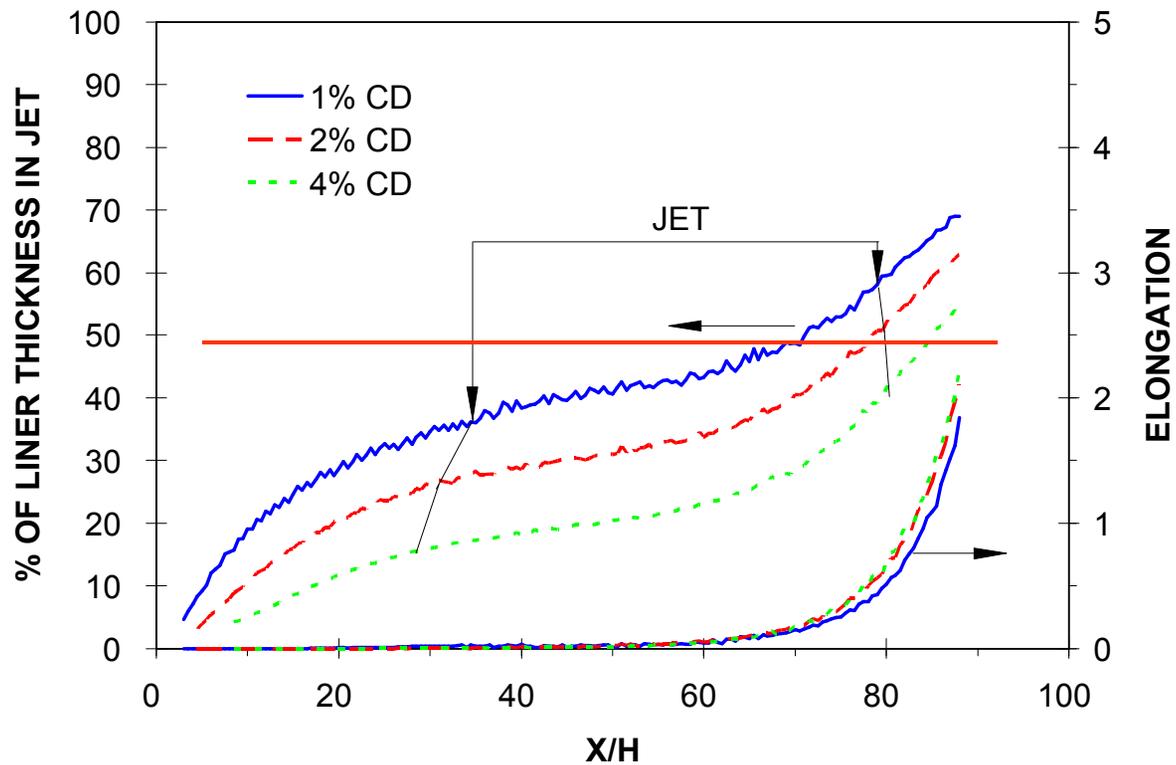




Figure 5: jet from a 72mm charge, 60°, 0.4mm (0.5%CD) thick copper

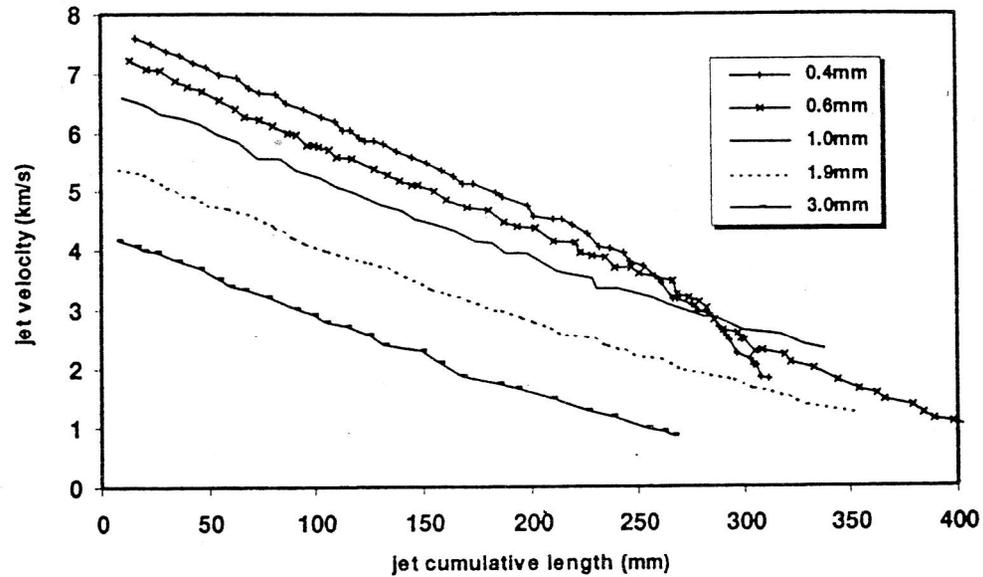


Figure 3: particulation behavior of jets from 60° copper cones with different wall thickness: experimental jet velocity vs. cumulative length from radiographs

P. Y. Chanteret and A. Lichtenberger, "About Varying Shaped Charge Liner Thickness", in Proceedings 17th Int. Symp. On Ballistics, Midrand, South-Africa, 1998.

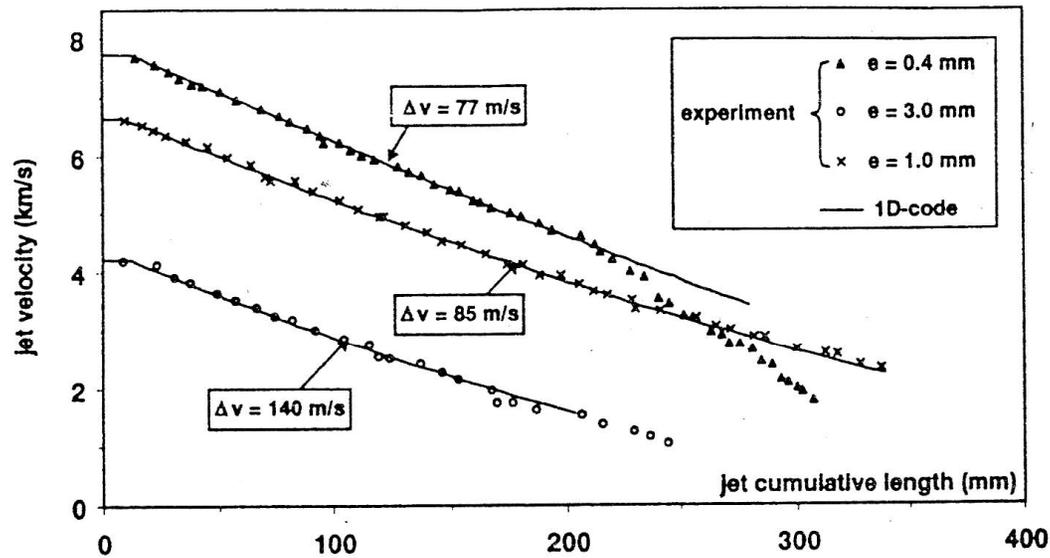


Figure 11: experimental and 1D-code calculated jet velocity vs. cumulative length; 60° copper liners with 0.9%, 2.2% and 6.7% CD liner wall thickness.

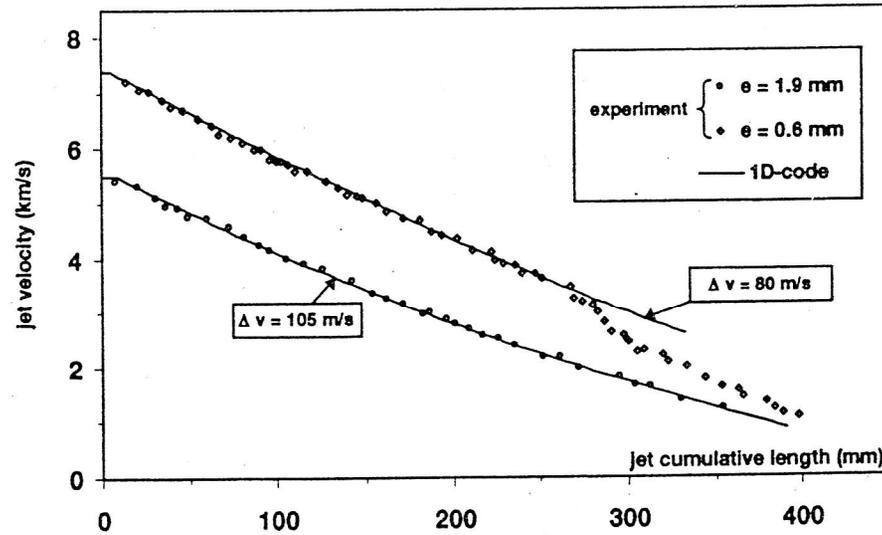
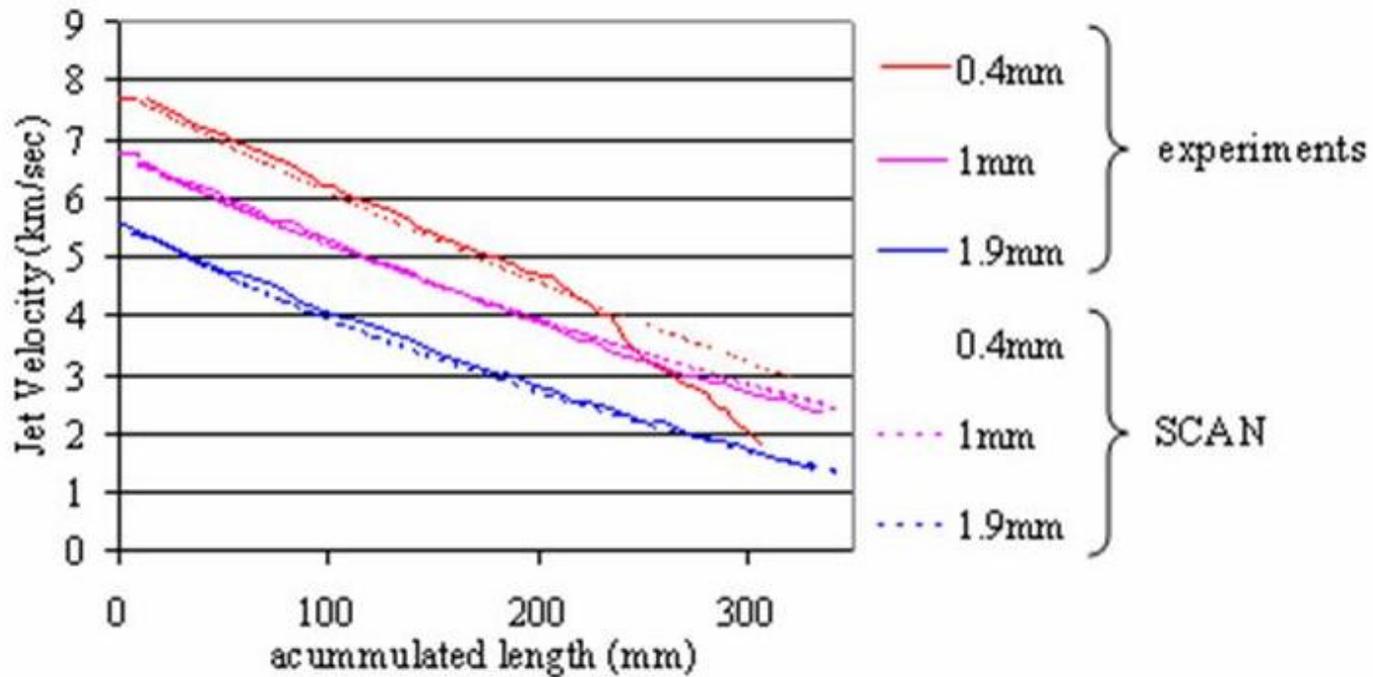
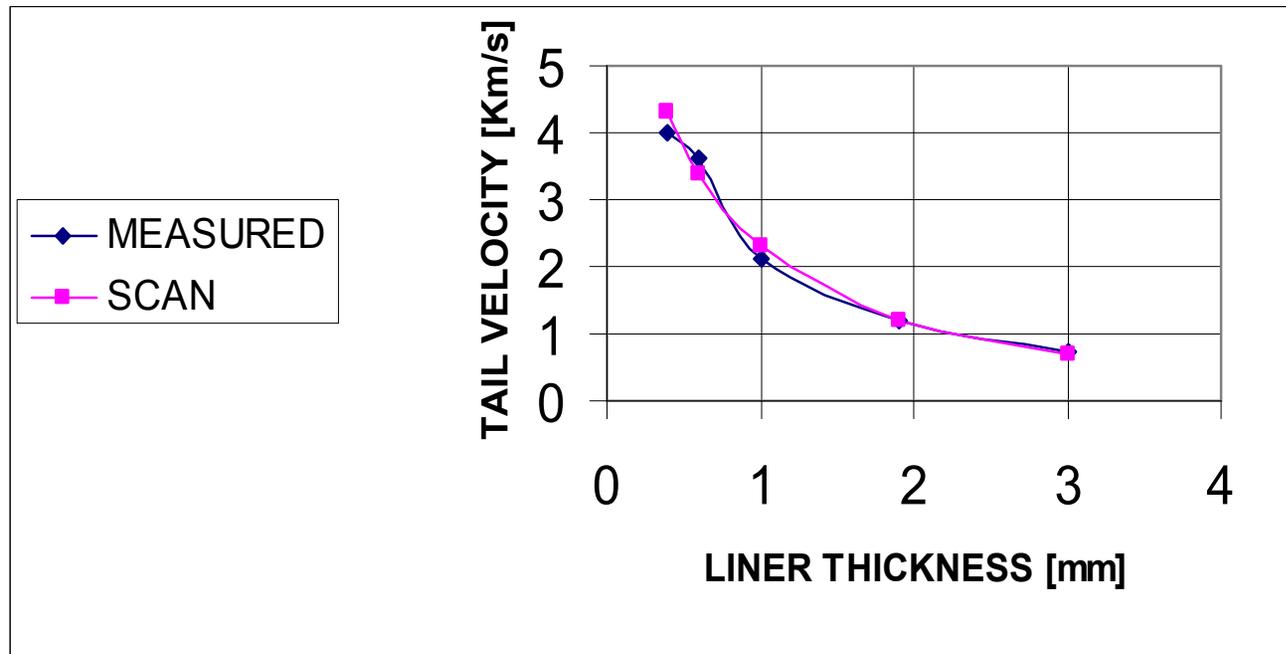


Figure 12: experimental and 1D-code calculated jet velocity vs. cumulative length; 60° copper liners with 1.3% and 4.2% CD liner wall thickness.

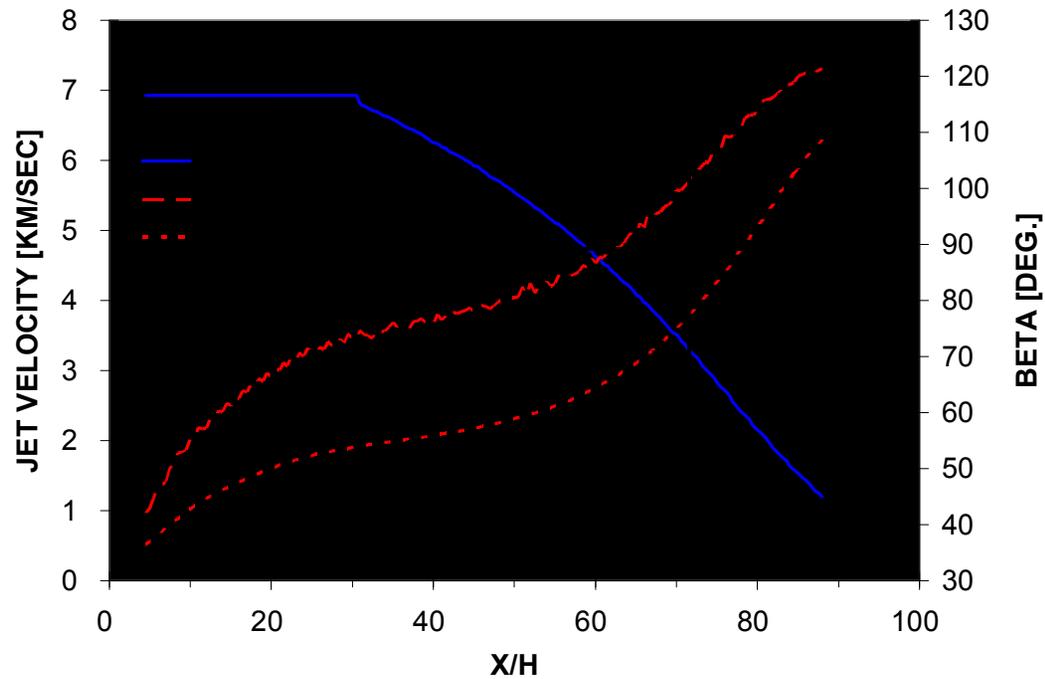


SCAN calculations compared to Chanteret and Lichtenberger experimental results. The sudden change in the slope seen in the 0.4mm liner characteristic is where the appendix begins to form in this case (it is in the process adjustment) .



Experimental results (Chanteret and Lichtenberger) of the jet velocity where the Appendix starts, as a function of the liner thickness, compared to the SCAN theoretical results.

SCAN CALCULATION FOR 2% CD LINER THICKNESS



CONCLUSIONS:

THE APPENDIX REGION WAS IDENTIFIED.

$$\beta \geq 90^\circ$$

$$V_s = V_1 - V_f < 0$$

HIGH STRAIN RATE.

HIGH VELOCITY DIFFERENCE BETWEEN PARTICLES.

NON STABLE ZONE.

EFFECTIVE FOR PENETRATING SOFT TARGETS.

