The Effects of Powder, Barrel Length & Velocity on Distance Determination

Daniel Botello, B.S.[1]; Dwight Deskins, B.S.[2]; Jessica Copeland, B.S.[2]; Catherine G. Rushton, M.S.F.S.[1]; Pamela Staton, Ph.D.[1]

[1]Marshall University Forensic Science Program, 1401 Forensic Science Dr., Huntington, WV 25701
[2] Kentucky state Police – Eastern Lab, 1550 Wolohan Dr. – Suite 2, Ashland, KY 41102

MARSHALL™
FORENSIC SCIENCE

Question:

Does a firearms examiner need the gun and specific ammo used in a crime to determine distance of the shooter?

The Study

- 357 Magnum revolvers can accommodate for both 38 Special & 357 Magnum
- Velocities recorded using chronograph
- Target is a plain white cotton fabric affixed to cardstock
- Range was varied from 3" to furthest distance that produced a pattern
- Powder type was varied at each range to observe patterns at both max and min loads

Overview

- The Guns
- The Setup
  - Ransom rest
- Reloading
- Chemical Enhancements
- The Data
- Discussion
- Conclusions

The Guns

Rossi 92 SRC

- 357 Magnum Lever-Action Rifle
- 20" Barrel Length
- 5.75 Lbs
- 5.5 Lb Trigger Pull
- 11 Round Magazine Capacity

Quick Disassemble

Disassemble Continued

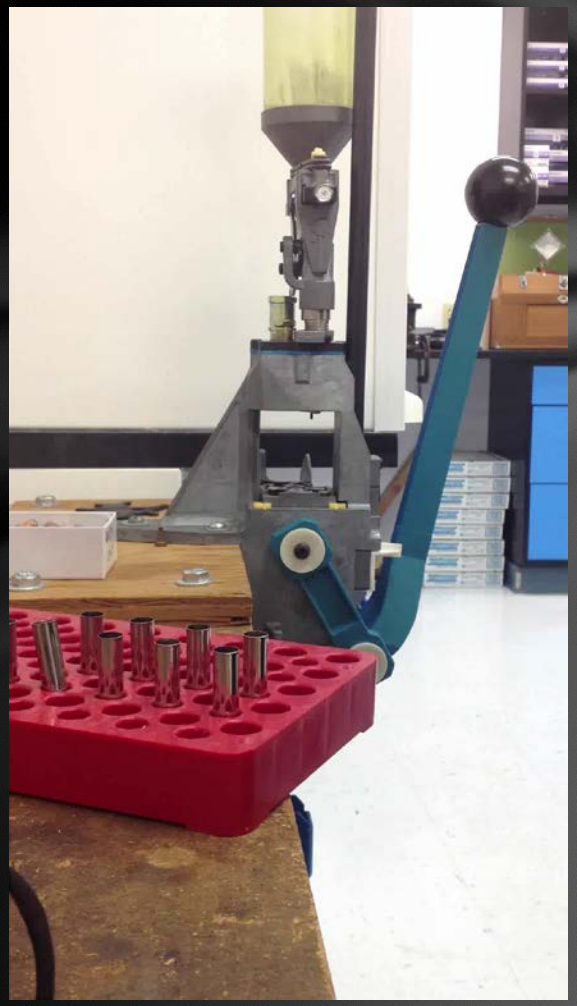
DA v. SA

The Setup

Ransom Rest

Reloading

Reloading Cont…



Chemical Enhancements: MG Test

Modified Griess Test:

Used to measure nitrite residues on a target formed during the burning of smokeless powder.

Simplified Testing Procedures:

- Place desensitized photo paper down glossy side up.
- Place questioned material suspected area face down on top of photo paper.
- Dampen a cheesecloth with 15% Glacial Acetic Acid and place on top of material.
- Use an iron to steam any nitrites from target to photo paper.
- Observe color change.

Chemical Enhancements: So Rho

Sodium Rhodizonate

Used to measure lead particles on the target that are typically produced by the primer charge.

Simplified Testing Procedures:

- Spray Sodium Rhodizonate solution directly onto target and allow to penetrate for 1 minute
  - Results in pink reaction where positive for heavy metals
- Spray buffer solution (pH 2.8) on the target and allow to react.
  - Removes the yellow background color of negative areas
  - Consists of sodium bitrate and tartaric acid
- Spray or drop 5% HCl Acid onto positive areas to indicate presence of Pb
  - Results in purple color change

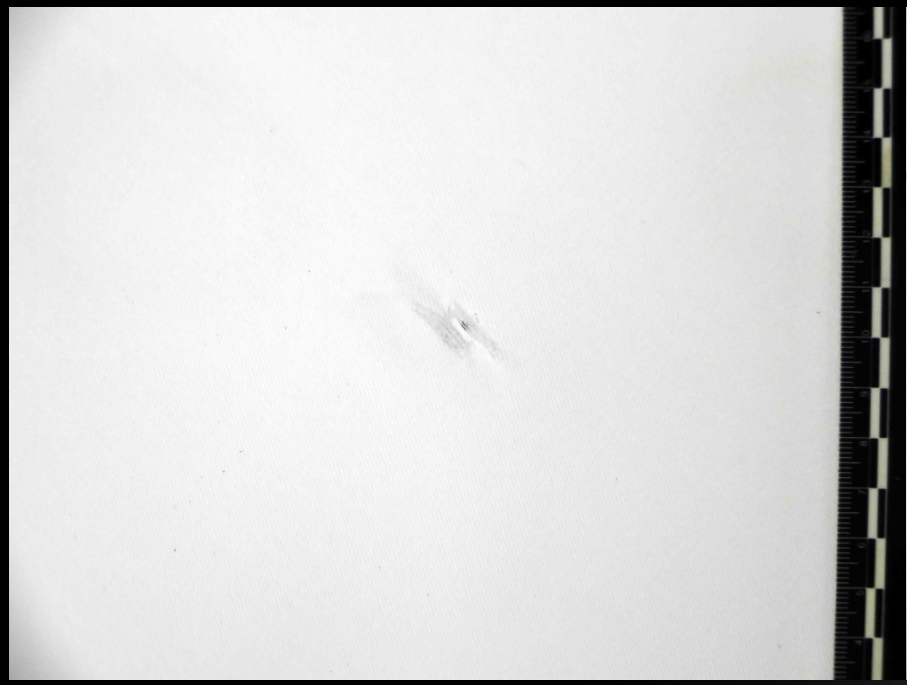
Overview

- The Guns
- The Setup
  - Ransom rest
- Reloading
- Chemical Enhancements
- The Data
- Discussion
- Conclusions

Raw Data Summary

- 5 Firearms
- 14 unique ammunition types
- 302 patterns produced
- Minimum Bullet Velocity: 622 FPS
- Maximum Bullet Velocity: 2170 FPS
- Shortest Maximum Distance: 12 inches
- Longest Maximum Distance: 48 inches
- Furthest distance target cloth was carried: 133 inches

Pattern Variation

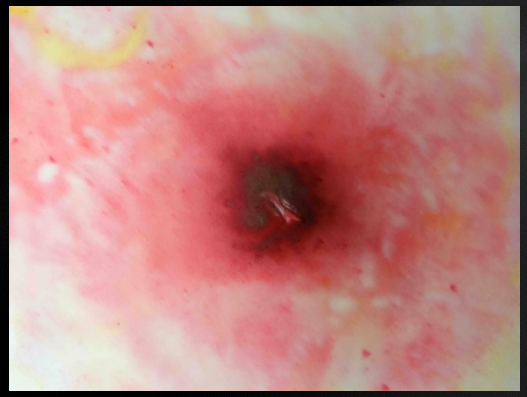


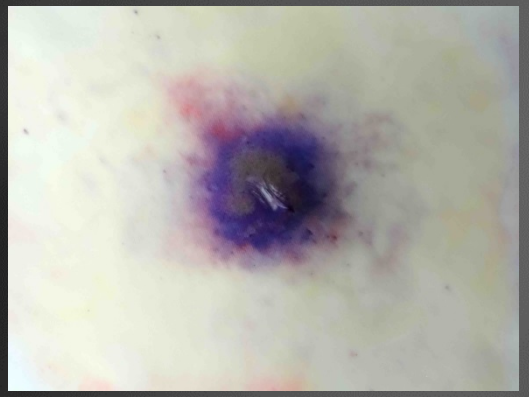
Clays 38 Special @ 18”

Blue Dot 357 Magnum 18”

Clays Series Comparison

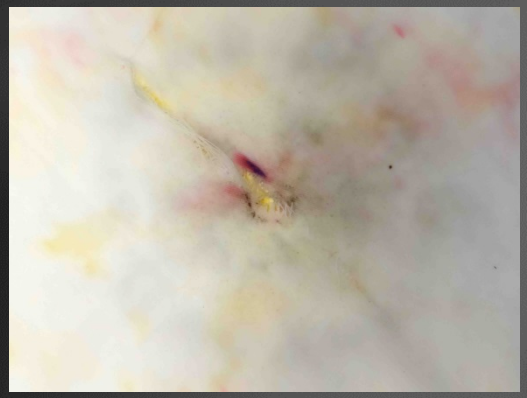
Clays 3.5 Grains @ 3”





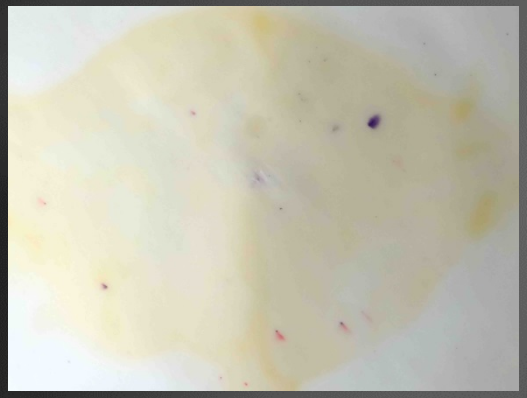
Visual Comparison

Remington UMC 125 SJ @ 3”

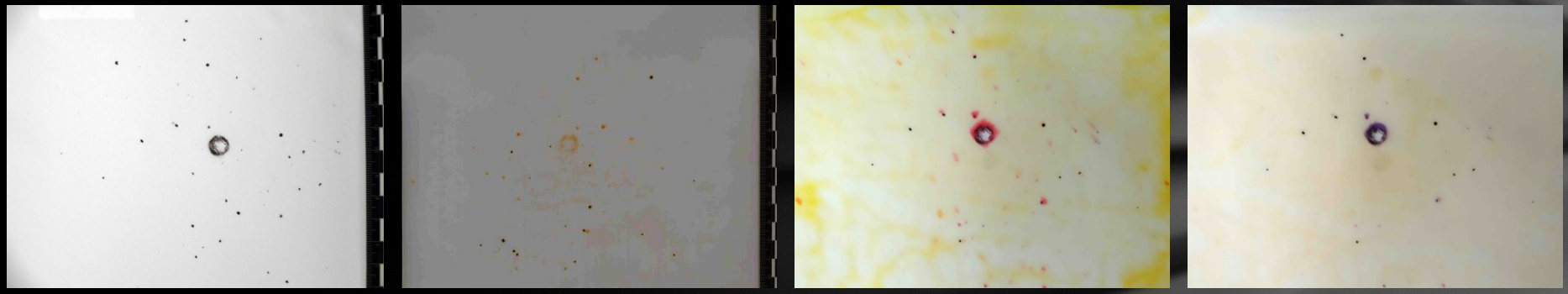


Clays Series Comparison

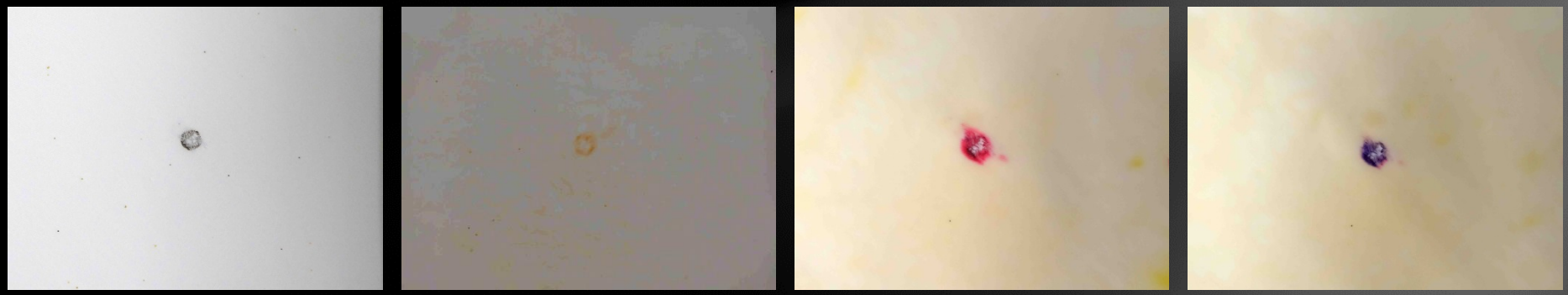
Clays 3.5 Grains @ 12”



Maximum Distances



Blue Dot @ 36”



Remington 110 JHP @ 48”

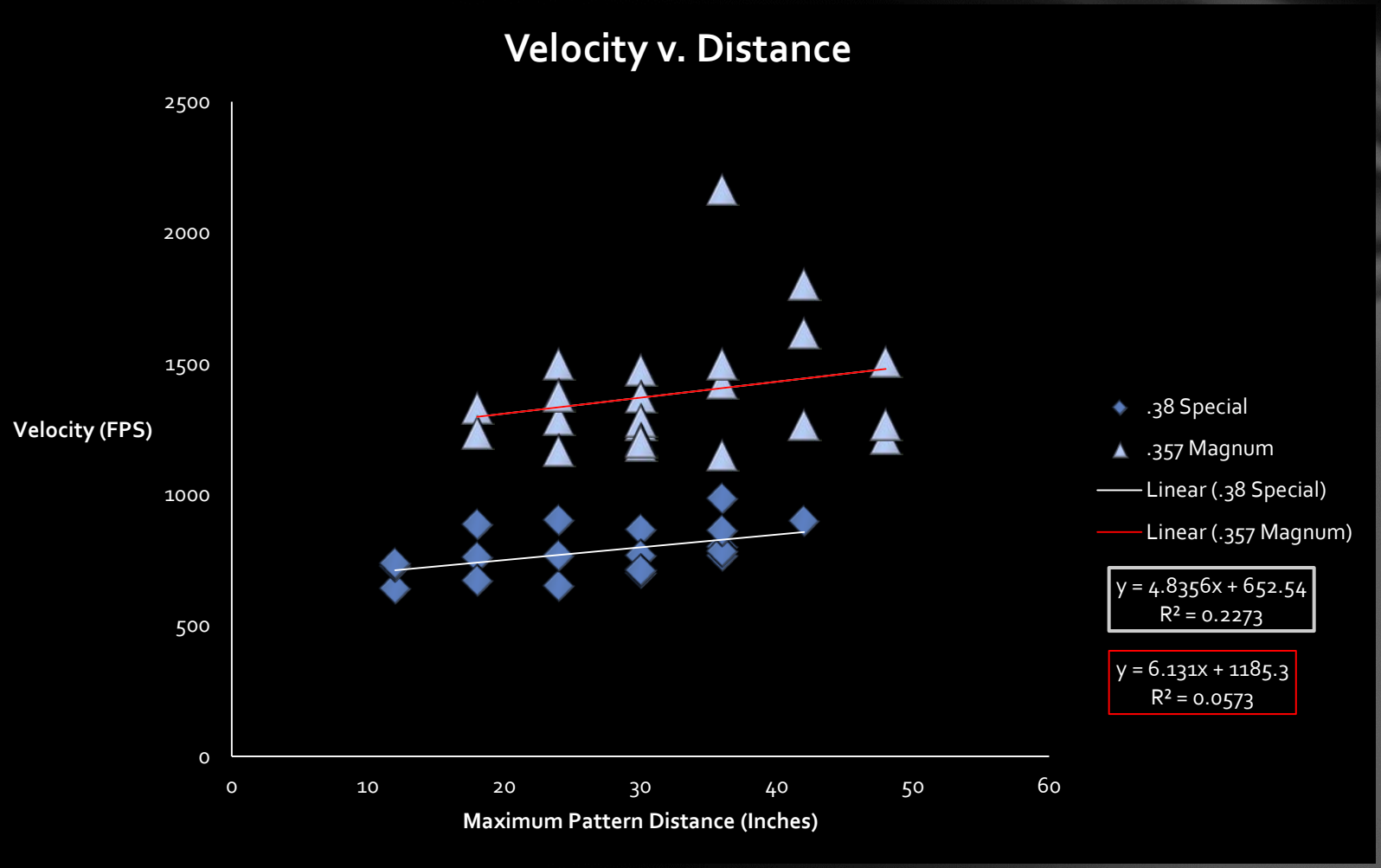
Raw Data 38 Special

38 Special Velocity Stats (Feet per second)				
	Minimum Velocity	Maximum Velocity	Velocity Spread	Average Velocity
All Barrels	622	1003	381	796
2" Barrel	622	788	166	696
4" Barrel	676	937	261	797
8 3/8" Barrel	721	1003	282	882

Raw Data 357 Magnum

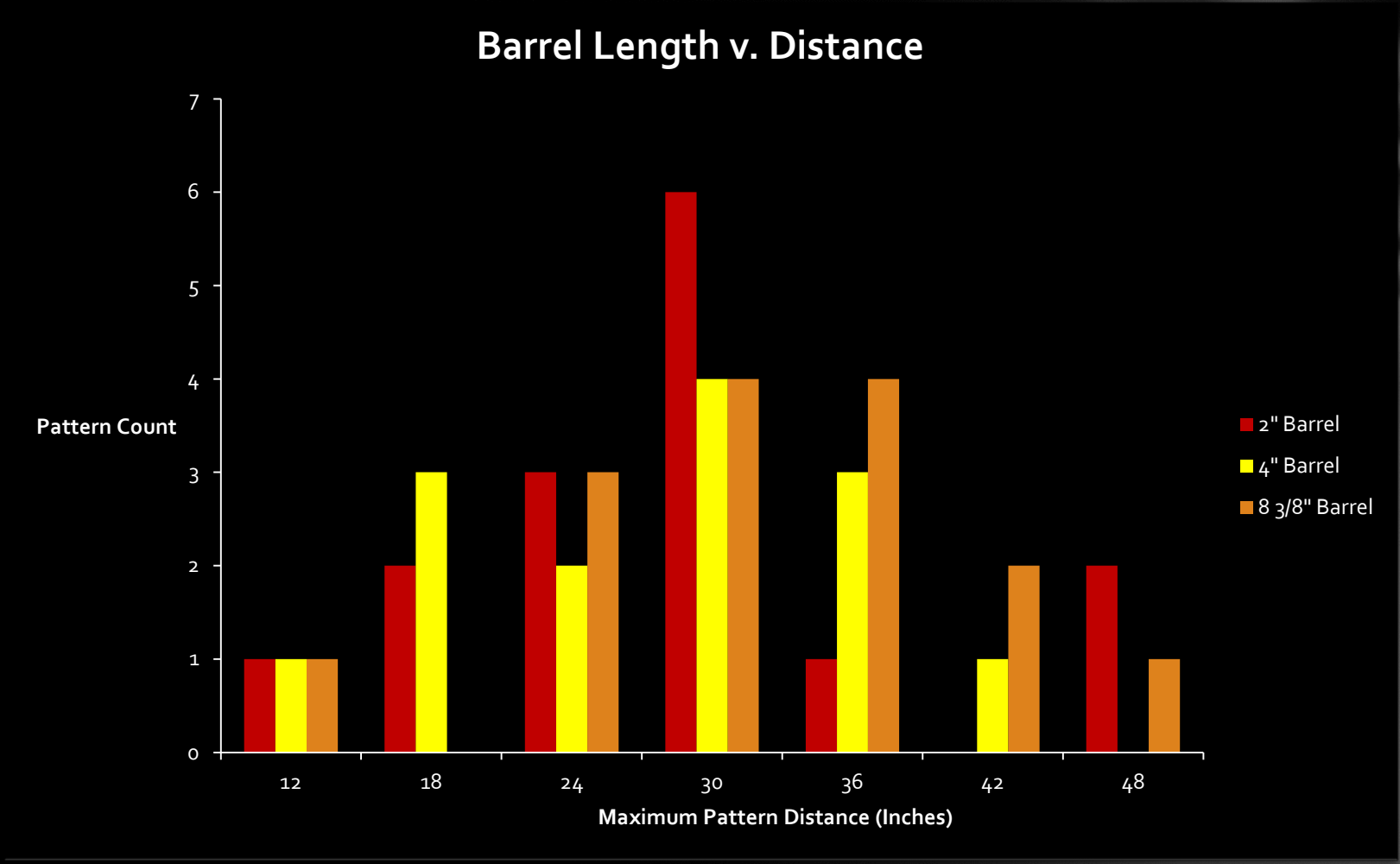
357 Magnum Velocity Stats (Feet per second)				
	Minimum Velocity	Maximum Velocity	Velocity Spread	Average Velocity
All Barrels	1125	2170	1045	1436
2.5" Barrel	1125	1352	227	1236
4" Barrel	1210	1510	300	1329
8 3/8" Barrel	1316	1710	394	1477
20" Barrel	1749	2170	421	1956

GSR Visual Patterns: Velocity



Pattern v. Barrel Length

GSR Visual Patterns: Barrel Length



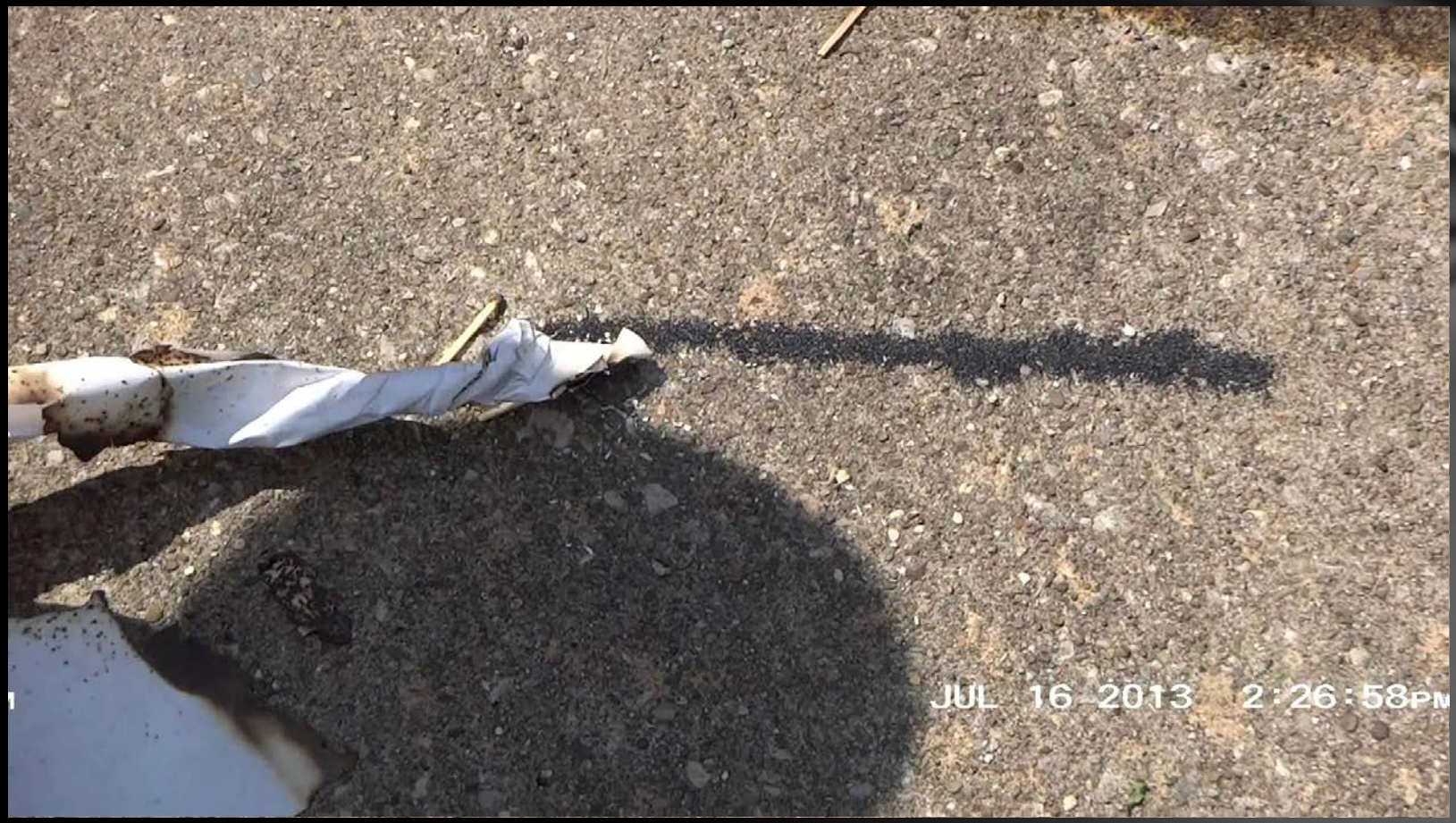
GSR Visual Patterns: Powders

Maximum Distance Representation by Barrel Length							
	38 Special			357 Magnum			
	2" Barrel	4" Barrel	8 3/8" Barrel	2.5" Barrel	4" Barrel	8" Barrel	20" Barrel
Remington 110 JHP 357 Magnum				48″	42"	48"	
Win 110 JHP 357 Magnum				30"	30"	30"	
Fed 110 JHP 357 Magnum				30"	24"	30"	
Rem UMC 125 JSP 357 Magnum				48"	30"	42"	36"
Rem UMC 130 FMJ 38 Special	30"	36"	42"				
Winchester 148 LWC 38 Special	30″		30″				
Blue Dot	30"	36"	36"	36″	30"	36"	42"
Accurate No.5	24"	36"	36"	30″	30"	36"	
Unique	18"	18"	24"	24″	18"	24"	
Bullseye	18"	24"	30"	24″	18"	24"	
Clays	12"	12"	12"				

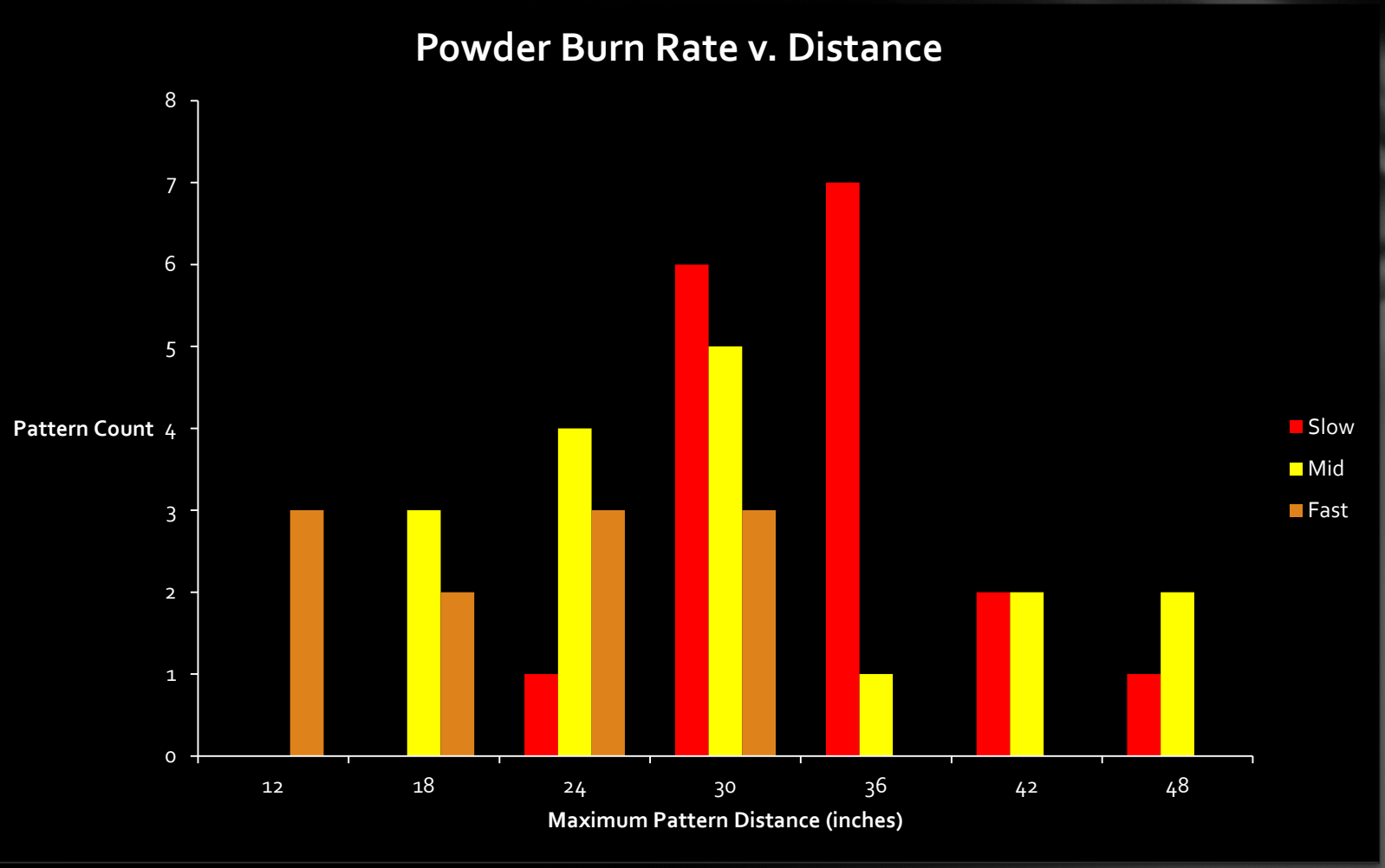
The Ammunition & Burn Rate

	Relative Burn Rate	Minimum Load	Maximum Load
Remington 110 JHP 357 Magnum	Mid		9.08 Grains
Winchester 110 JHP 357 Magnum	Mid		9.02 Grains
Federal 110 JHP 357 Magnum	Mid		9.64 Grains
Remington UMC 125 JSP 357 Magnum	Slow		17.54 Grains
Remington UMC 130 FMJ 38 Special	Mid		4.88 Grains
Winchester 148 LWC 38 Special	Fast		2.7 Grains
Hercules Blue Dot	Slow	7.5 Grains	12.0 Grains
Accurate No. 5	Slow	6.1 Grains	11.0 Grains
Hercules Unique	Mid	5.0 Grains	9.6 Grains
Hercules Bullseye	Fast	4.0 Grains	8.0 Grains
Hogdgon Clays	Fast	3.5 Grains	

Burn Rate?



Powder Burn Rate Correlation



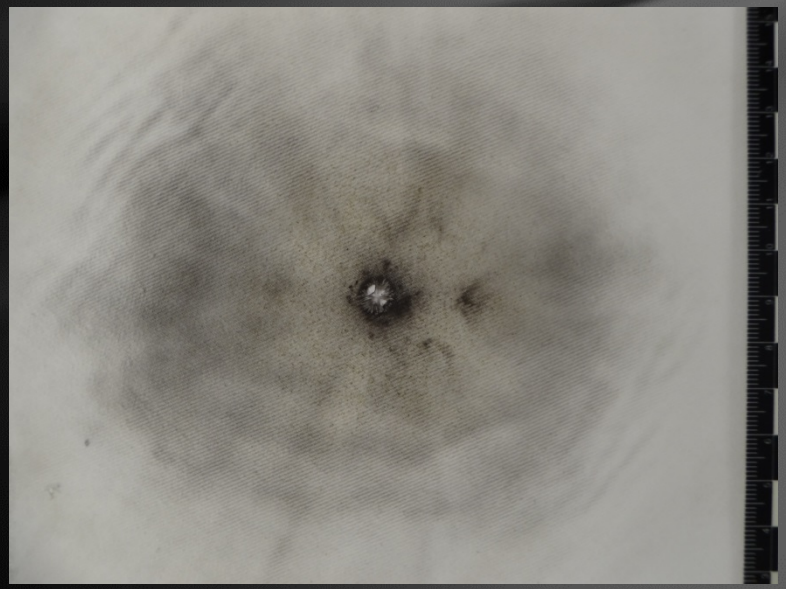
Conclusions

- Velocity may play a small role, but overall not a major factor
- Barrel length shows some correlation in reloaded 38 special, but not 357
- Powder burn rate shows the highest correlation to maximum distance achieved
  - Slower powders will persist longer and have patterns at further distances
  - Faster powders will burn out sooner and do not produce patterns at further distances
- Examiner would expect to see a smoke pattern up to 12”
  - Beyond 12” pattern results are variable with ammo and gun used

Other factors

- These patterns were produced under laboratory conditions and were not exposed to excessive movement, blood or handling.
- Controlled environment also means no environmental factors came into play.
- Targets did not have sturdy backing and this was shown to affect the amount of tearing of target fabric

Rossi 92SRC @ 3" w/ Rem UMC 125 JSP w/o backstop



Rossi 92SRC @ 3" w/ Rem UMC 125 JSP w/ backstop

References

- Adams, Beckett. (2013). 'Reloading': The Booming Gun Hobby and What It Could Mean for the Ammunition Industry. Retrieved from http://news.yahoo.com/reloading-booming-gun-hobby-could-mean-ammunition-industry-122212211.html
- Alliant Powder. (n.d.). Reloader's Guide. Retrieved from http://www.alliantpowder.com/reloaders/RecipeList.aspx?gtypeid=1
- Brudenell, A. (2012). Gunshot Residues from a Pistol and Pistol Caliber Carbine. AFTE Journal, 44 (3). 218 - 226.
- Crego, L. (2011). Distance Determination Results When Utilizing the Same Make, Model and Barrel Length Firearms. AFTE Journal, 43 (4). 288 – 302.
- Dillon, J. (1990). The Modified Griess Test: A Chemically Specific Chromophoric Test for Nitrite Compounds in Gunshot Residues. AFTE Journal, 22 (3). 243 – 250.
- Dillon, J. (1990). The Sodium Rhodizonate Test: A Chemically Specific Chromophoric Test for Lead in Gunshot Residues. AFTE Journal. 22 (3). 251 – 256.
- Grain. (2013). In Encyclopædia Britannica. Retrieved from http://www.britannica.com/EBchecked/topic/240807/grain
- Haag, L., Tew, J. (2006). The Effect of Revolver Cylinder Gap on GSR Production and Projectile Velocity. AFTE Journal, 38 (3). 204 – 212.

References Continued

- Halim, M., Ahmad, U., Yew, C., Abdullah, M. (2010). Analysis of Gunshot Residue Deposited on Cotton Cloth Target at Close Range Shooting Distances. Malaysian Journal of Forensic Sciences, 1(1), 48-53. Retrieved from http://www.academia.edu/859499/Analysis_of_Gunshot_Residues_Deposited_on_Cotton_Cloth_Target_at_Close_Range_Shooting_Distance
- Hodgdon Powder Co. (1992). Hodgdon Smokeless Powder Data Manual (26th Ed.). Kansas: Author.
- Hodgdon Powder Co. (n.d.). Reloading Data Center. Retrieved from http://data.hodgdon.com/cartridge_load.asp
- How Far Will Shooting Distance Determination Take Your Case. (2009). Under the Scope, 9 (2). Retrieved from http://www.mshp.dps.mo.gov/MSHPWeb/Publications/OtherPublications/documents/underTheScope9-2.pdf
- Speer Omark Industries. (1979). Reloading Manual Number Ten for Rifle and Pistol. Idaho: Author.
- SWGGUN. (2012). Guidelines for Gunshot Residue Distance Determinations. AFTE Journal, 44 (4). 371– 374.
- Trimpe , Michael. (2011). The Current Status of GSR Examinations. FBI Law Enforcement Bulletin. Retrieved from http://www.fbi.gov/stats-services/publications/law-enforcement-bulletin/may_2011/The%20Current%20Status%20of%20GSR%20Examinations
- Western Powders. (n.d.). Reloading & Loading Data Guide. Retrieved from http://www.accuratepowder.com/load-data/

Acknowledgements

- Dwight Deskins, Jessica Copeland & the KSP Eastern Regional Forensic Laboratory
- Dr. Staton
- Mrs. Rushton
- Jessica Ybarra
- Alison Quereau
- Scott Doyle

Questions?

http://www.youtube.com/watch?v=QfDoQwIAaXg