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Shot Pulse Width Variations Among Similar Carbines

Visible Assets Inc.

Tuesday, September 29, 2009, Version 1-2

PURPOSE: To study shot pulse width variations among a small population of carbines.

BACKGROUND: The Visible Assets shot counting tag is a RuBee enabled, battery operated device that is mounted within the handle of a carbine or handgun and senses acceleration of the weapon as it is discharged. It counts shots and communicates wirelessly over short distances (a few feet) to a wireless modem equipped laptop or PDA. The tag optionally has an analog output via shielded cable that can provide detailed weapon diagnostics through software on a laptop. The tag itself can analyze the same data that is output over the analog port and provide warning flags and summary statistics on weapon performance, but does not have sufficient bandwidth to transmit the entire high fidelity analog signals wirelessly.

METHODS: Four Colt M4 carbines were selected from a population of about one hundred at the Kirtland Air Force base in Albuquerque New Mexico. Three of these weapons were mid life with 2K to 5K rounds fired. One was brand new.

Two Visible Assets shot counting tags were used to gather analog shot traces for a total of 456 shots over a period of two days. On the first day there was a mix of single shots and bursts up to 30 rounds on each gun. On the second day each gun was fitted with the opposite tag and fired 10 single shots and two 28 round bursts.

Analog traces were acquired with a Rigol 1022 digital storage oscilloscope and processed with Visible Assets in-house analysis software to extract features and then analyzed with DataDesk 6.2.1 software to calculate statistics and find patterns.

The width of peaks was calculated with the widely used ‘peak width at half height’ metric.

RESULTS:

Figure 1 shows the width of the shot peaks found in the analog acceleration data for each of the four individual weapons. The center of the histogram of all 456 shots is at about 200 microSeconds width. As can be seen the distribution of the peak widths is somewhat different for each of the four weapons with the distribution for weapon ‘b’ being the most distinct. It can also be noted that all of the higher width peaks are associated with that weapon. Weapon ‘b’ is the brand new carbine.

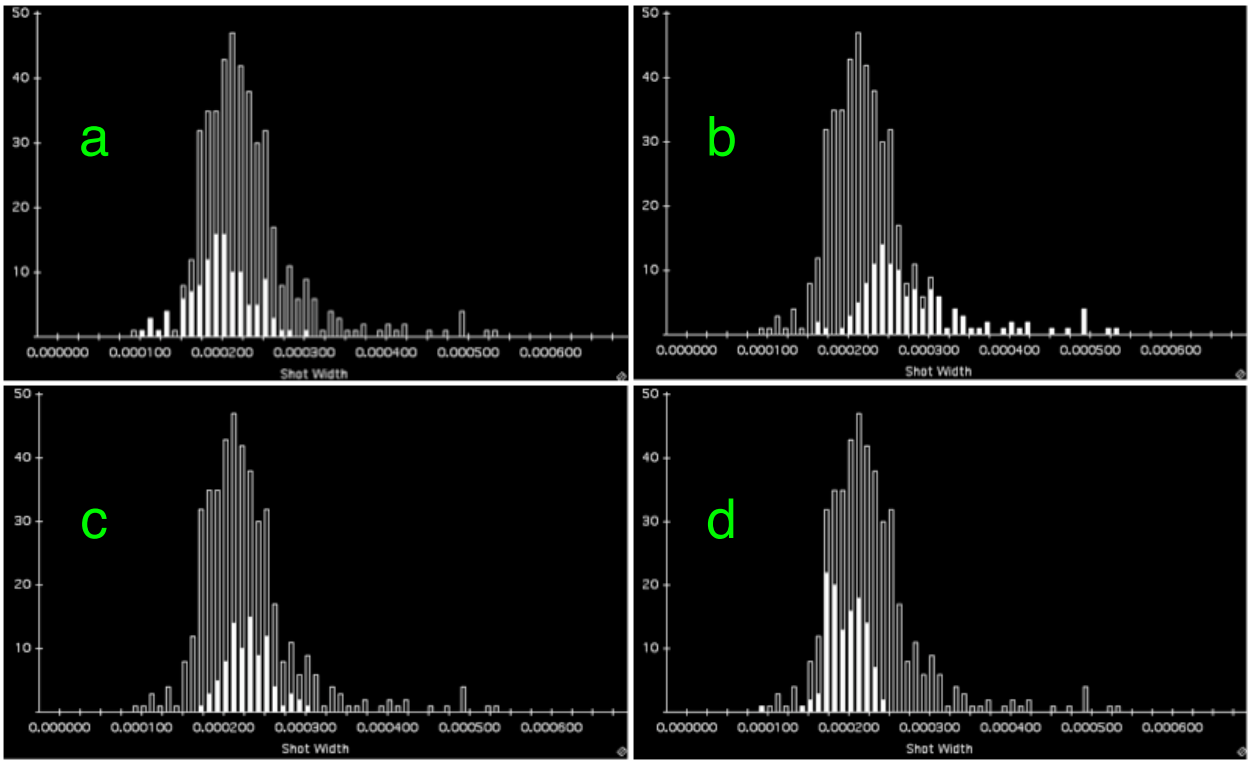


Figure 1; Distribution of shot peak widths for each of four weapons.

Figure 2 shows the same data as in Figure 1, but further broken down by tag. Two tags were used on each gun and they were labeled 1000 and 1001 respectively.

From Figure 2 it can be seen that a slight tag related bias existed in terms of the shot pulse width that is measured for each gun. In particular the shot pulses appear slightly narrower in the acceleration traces taken from tag 1000.

Data was taken with one particular tag on any given weapon on one day and the other tag was used on that weapon on the second day.

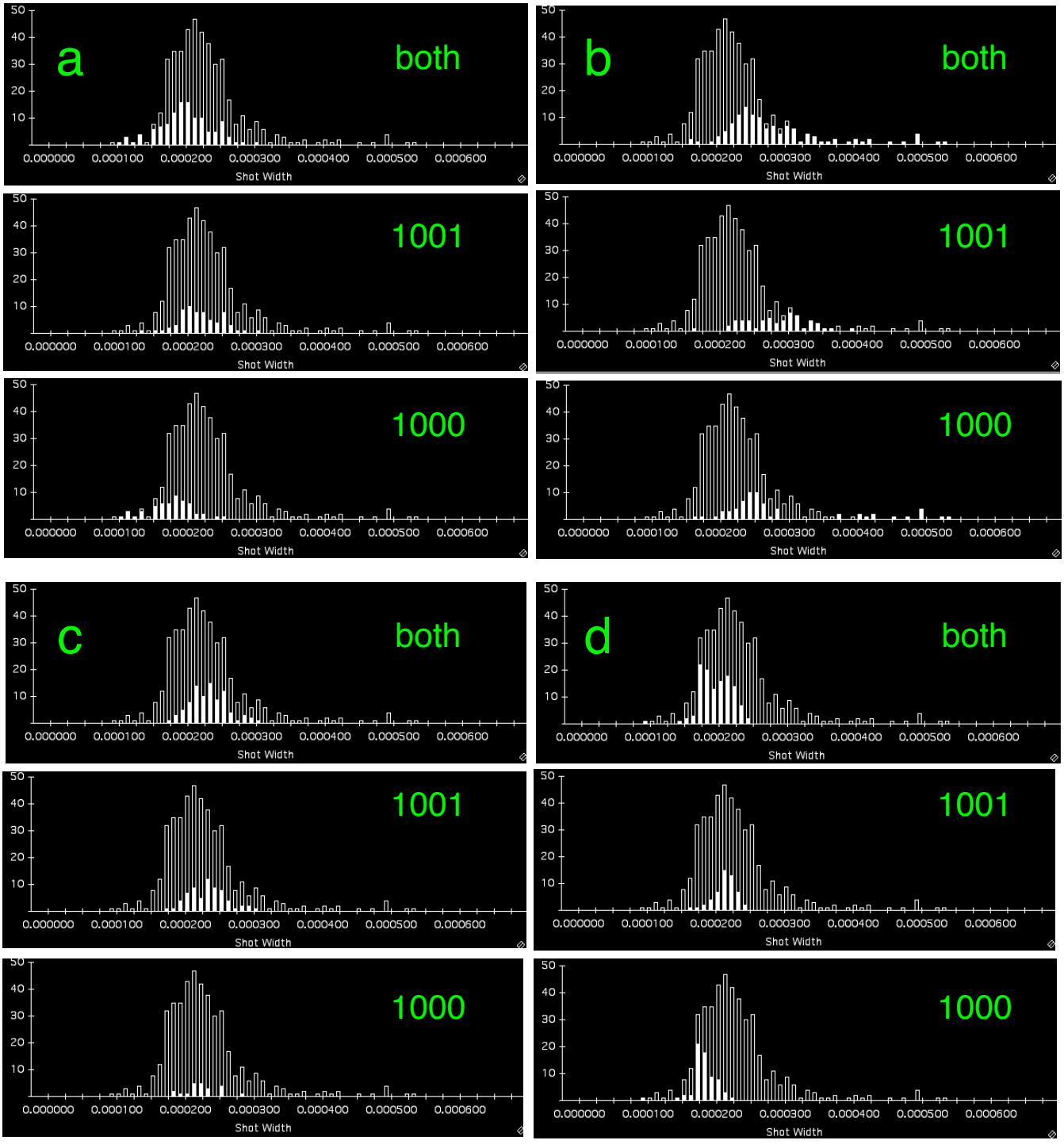
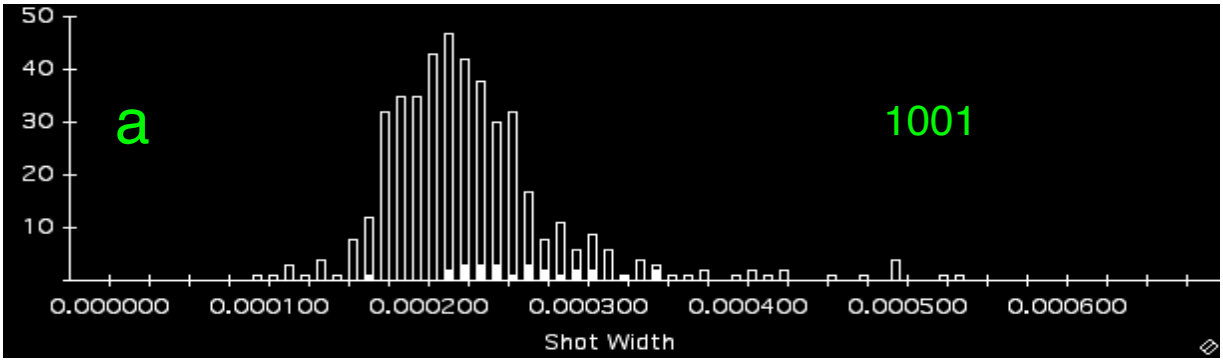


Figure 2; Shot pulse width further broken down by tag ID.

Figure 3 further breaks down the width of the shot pulses taken from weapon b (the brand new weapon) in a time sequence. Parts a through e of Figure 3 occur in time sequence. Part a is some single shots and some short bursts totaling about 25 rounds and starting from a cold weapon on day 1. Part b is a 30 round burst on that same day.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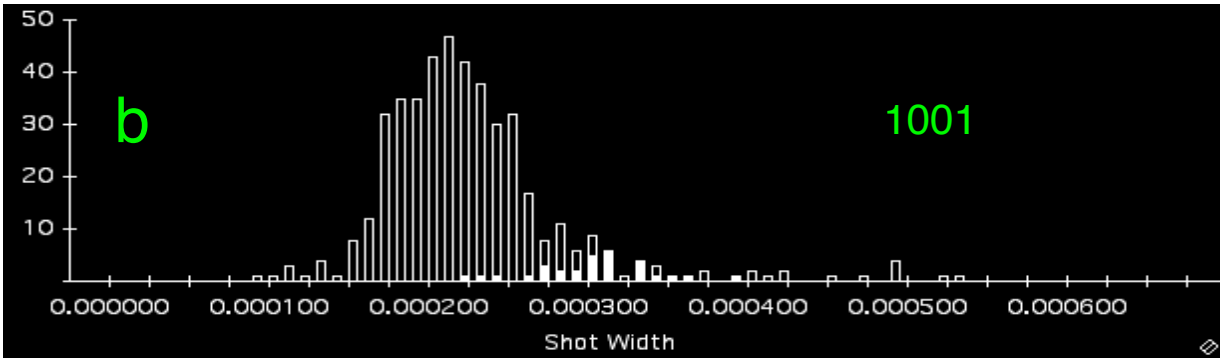
Shot Width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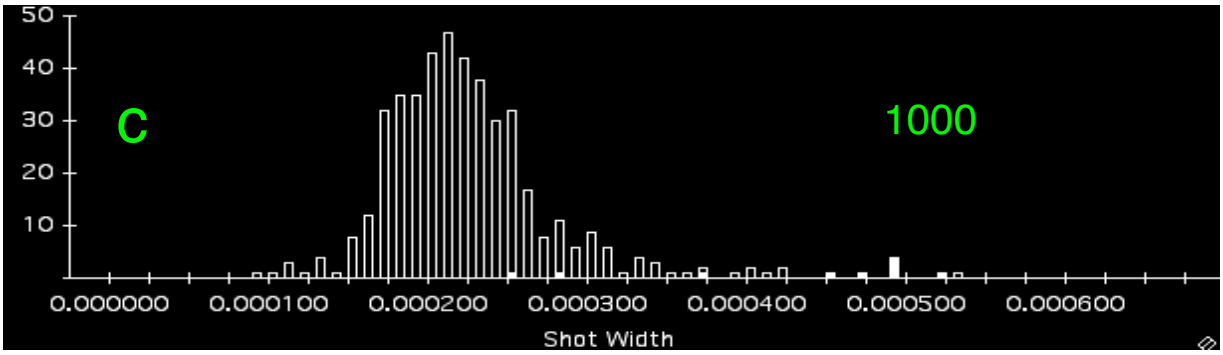
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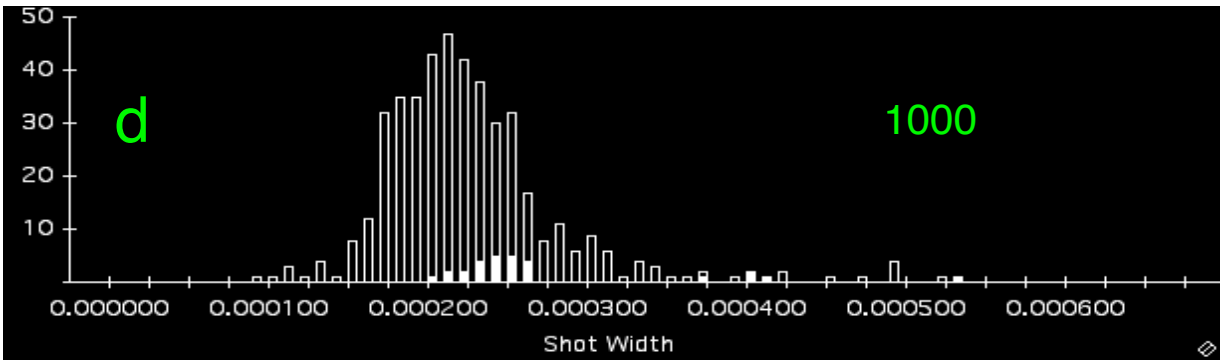
Shot Width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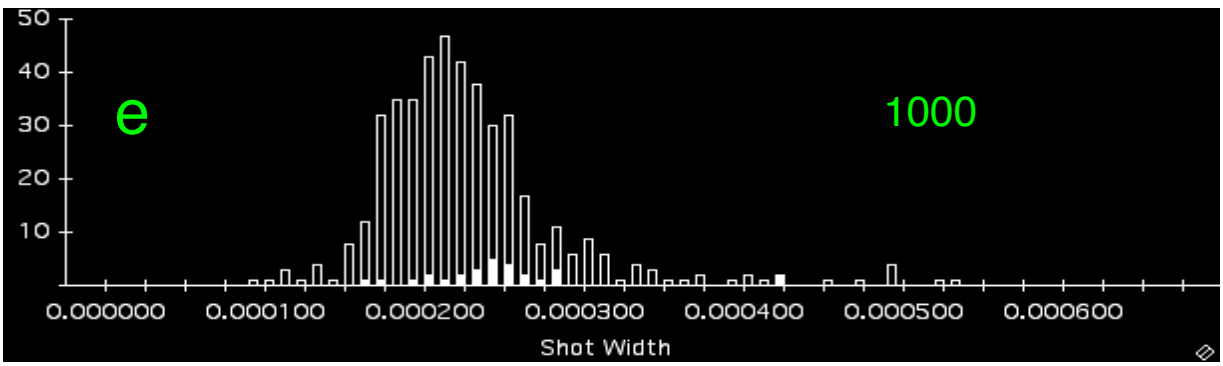
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Shot Width

Figure 3 parts c, d and e happened on the second day and are 10 single shots in part c and a 28 round burst in each of part c and d.

As can be seen tag 1000 was used on the second day suggesting there is likely a bias toward shot pulses appearing narrower on the second day for parts c, d and e.

What can be seen from the time sequence is that all of the widest shot pulses out of the entire 456 rounds fired came from the one new gun. Also most of the widest pulses were from single fire cases on the second day when the measurement bias due to the tag was actually toward narrower pulses.

Shots fired in a burst were statistically on the wide end of the population of all shots fired, with the bursts fired on the second day being generally somewhat narrower.

Within these bursts some, but not all, of the widest pulses were the first shot in the burst.

The first shots fired on the weapon had the widest variability.

CONCLUSION:

There are clear patterns measured in the shot pulse widths on data taken from the four Colt M4 weapons. It is not clear that the three mid life weapons can be distinguished from each other, although the history of each of these weapons is not known in detail.

It is clear, however, that the new weapon can be distinguished from the mid life weapons by shot pulse width alone. (It would be interesting to see if shot pulse width would be helpful in distinguishing between mid life and end of life weapons.)

It also appears that the statistical characteristics of the shot pulse width on the new weapon are changing with time and moving more toward the statistical norm of the other three weapons over the interval measured which was in the order of 100 rounds fired from the weapon.

A possible explanation for the observed data is that initially the barrel of the weapon is somewhat narrower than it becomes at mid life and that friction between the bullet and the barrel is causing the bullet to have a longer lasting acceleration and possibly a reduced muzzle velocity for some number of initial rounds. The rounds with the wider shot pulses also tend toward single shots, which is what one would expect as the barrel has more chance to cool for single shots than it does when shots are fired in a long burst.

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Document Control

Document Status

6 Total Pages

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Revision Control and History

RDG	29-Sep-2009	V 1-1	Initial document completed.
JKS	Oct 1	V1-2	Review

Signatures