ACCURACY COMPARISON OF AN OPEN vs CLOSED ELECTRONIC TARGET SYSTEMS

EXECUTIVE SUMMARY

Since the arrival of E-Targets on the North American scene there has been vigorous discussion regarding their viability. There has been a huge acceptance of E-Targets, but no rigorous testing of their accuracy. Because of the lack of publicly available test data in the US, Rick Ratzlaff of goBallistic LLC, a distributor of Hex Systems organized a test to compare the accuracy of one example of open vs closed electronic target systems. Three electronic target systems were selected for this test: HEXTA, SOLO and ShotMarker. HEXTA is a closed system where the acoustic sensors are protected from exterior disturbance by rubber membranes and corflute; closed system use the speed of sound as the signal speed to the acoustic sensors. SOLO and ShotMarker are open systems where the acoustic sensors are open to atmospheric elements; open systems depend on bullets speed to determine signal speed to the acoustic sensors. The test was conducted at 600, 800 and 1000 yards. The table below summarizes the results of the test; the table shows the percentage of shots that would fall within the suggested NRA error standard of 0.25". The results for ShotMarker are not shown due to setup problems; past testing have shown ShotMarker shot location accuracy similar to that of SOLO.

	HEXTA	SOLO
1000YD	92.0	28.0
800YD	95.0	55.0
600YD	97.2	52.8

INTRODUCTION

On April 16 2019, a test was conducted at the Tri Cities Shooting Association highpower range (aka Rattlesnake range). Three electronic target systems were tested:

HEXTA (https://www.hexsystems.com.au/) ,

SOLO (https://silvermountaintargetsusa.com/)

ShotMarker (https://www.autotrickler.com/ShotMarker.html)

The purpose of the test was to compare the shot location accuracy of a closed electronic target system versus open electronic systems. Open targets are becoming used more widely used in the US for competition and it is important to know their accuracy limitations. Closed electronic systems have the sensors closed in a boxlike structure that protects the sensors from atmospheric disturbances and does not require the measurement of terminal bullet velocity since calculations depend on the speed of sound. Open electronic target systems have the sensors open to the environment and require the measurement of terminal bullet velocity for shot location calculations. The test were done at three distances: 600, 1000, and 800yd. The 800yd test was done to test the effect of target offset since the 800yd line is offset by about 12deg from the target line.

TEST PROCEDURE

The open electronic target sensors were mounted on the HEXTA target which allowed using one test for all three systems to be done simultaneously. The HEXTA electronic target is a closed system where the sensors are closed inside a 7'x7'x7" box; the HEXTA target box was used to setup SOLO and ShotMarker sensors which are open electronic target systems. The sensors for the SOLO and ShotMarker are installed on 4"x6' wood slats which are screwed unto the HEXTA frame. The HEXTA target box was mounted in an A-frame levelled by wedges. Figure 1 shows the setup for the electronic target hardware. Figure 2 shows the HEXTA target and A-frame that supports it for the test. Figure 3 shows the shooting setup on the firing line. Two sheets of 3'x6' 1mm grid graph paper was stapled on the HEXA target face that allowed relatively easy measurement of shot hole locations. A 5" black disk was stapled at the center as an aiming mark. The graph paper was changed for each yard line. For those interested, the pdf of the grid paper used to measure shot location is attached below (zoom in to see details). Staples or Office Depot have the necessary large format printers to make 3'x6' copies. One can create customized graph paper by using the following website: https://incompetech.com/graphpaper/multiwidth/

Grid Paper:

multiwidth_6x6.pdf

The goal was to shoot thirty shots uniformly across the 6'x6' target face for each yard line. For the test, the 6.5 Creedmoor cartridge was used with the Nosler 140gr Custom Competition bullet with an average muzzle velocity of 2750fps measured by a LabRadar. Measurements of the horizontal and vertical locations of the open sensors where made and recorded. Five shots were done at 600yd to calibrate SOLO and ShotMarker. A Kestrel was used to measure wind and temperature at the firing line throughout the test.

TEST DATA ANALYSIS

It was intended to take thirty shots at each distance since this is the standard minimum sample size that is considered valid to determine normal distribution statistics. Thirty-seven shots were taken at 600yd because strong winds (see Appendix C) made it difficult to obtain a uniform spread of shots. Following is a pdf document showing the results for HEXTA:

HEXTA 600YD
STATISTICS.PDF

The reader can use their keyboard or pdf reader options to zoom the pdf document to better see the differences between paper and etarget shot locations.

All measurements are given in inches. Some explanations are needed for terms used in the error analysis summarized in the pdf documents. Despite the etarget manufacturer-recommended calibration procedure, the center of the etarget (acoustic center) will not be exactly the same as that of the paper target so a correction is needed; this correction is given by xErrMean (error in x coordinate) and yErrMean (error in y coordinate); this correction can be the equivalent of better calibration. stDev xErr and stDev yErr are the standard deviations in the error between the shot location on paper and corrected shot location on the etarget; the LC criterion is square root of the sum of squares of these errors and is used single criterion of etarget shot location accuracy. The first plot compares all the shot locations while the second plot is a close-up near the center of the target. The third plot shows the radial error in relations to its distance from the center. Radial error is the error in distance from the center of the target; on average, a positive average radial error penalizes the shooter since the indicated shot is further from the center than actual; on average, a negative average radial error favors the shooter since the indicated shot is closer to the center than actual.

Following is the pdf document showing the results for SOLO:

SOLO 600YD
STATISTICS.pdf

The next test was done at the 1000yd line. 30 shots were taken where the wind prevented the ideal uniform distribution of bullet impact. The results are shown for HEXTA and SOLO systems by the pdf documents below:

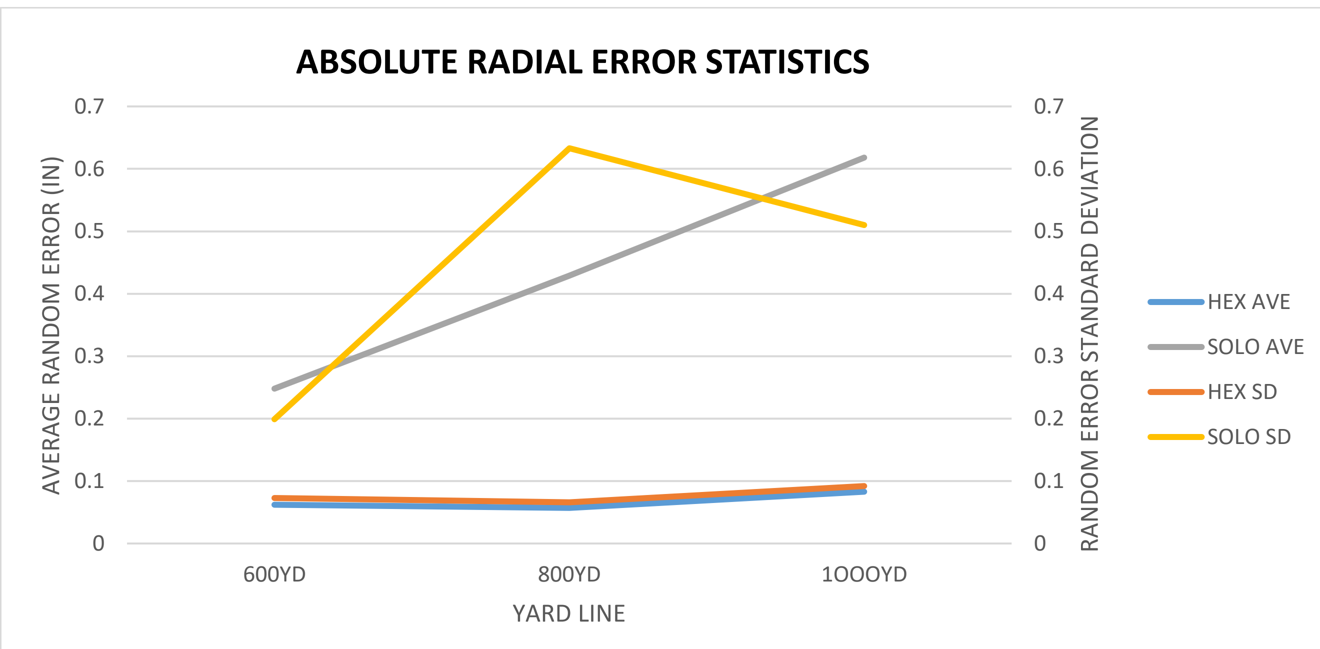
HEXTA 1000YD STATISTICS.PDF

SOLO 1000 STATISTICS.PDF

Finally the last test was done at 800yd. As said previously, this test was done to test the etargets response to bullets shot from an angle. The Rattlesnake 800 and 900yd lines are offset from the target line because of a gully between the 600 and 1000 yard lines. The 800yd firing line is offset by approximately 12deg. Only twenty shots were taken as we were low on ammo. Even with a severe 12 deg angle there was no obvious detrimental effect on HEX or SOLO accuracy except for one data point that has a significant effect on SOLO statistics. One shot (shot #5) has increased SOLO's average error by 43% and the error standard deviation by factor of over three. No explanation can be found at present for this odd behavior. Future testing should explore this further. The results for this test is show by the pdf documents below:

HEXTA 800yd STATISTICS.pdf

SOLO 800YD STATISTICS.pdf



As a summary, the table of etarget performance is shown below. The results show the average absolute radial error and its standard deviation; the radial error is the error in the distance of the shot hole location from the center of the target. A negative average radial error favors the shooter with a higher score on the average; a positive average radial errors penalizes the shooter with a lower score on the average. Absolute radial error considers both negative and positive radial error as equally bad for etarget performance so this statistic is shown below.

Also shown in the table is the Paper/Acoustic Center Offset. This offset is present because the calibration at 600yd did not perfectly align the paper center with the acoustic center. The SOLO offset at 600yd is very small but it increases with distance from the target. There was no calibration done on the range for HEXTA but its acoustic center does not change significantly with distance. HEXTA calibration is done at the factory.

SUMMARY STATISTICS OF ABSOLUTE RADIAL ERROR

	HEXTA		SOLO		PAPER/ACOUSTIC CENTER OFFSET			
	AVERAGE	SD	AVERAGE	SD	HEXTA X	HEXTA Y	SOLO X	SOLO Y
600 YARDS	0.062	0.073	0.248	0.199	0.172	2.151	-0.117	-0.052
800 YARDS	0.057	0.066	0.429	0.633	-0.175	2.130	1.122	-0.251
1000 YARDS	0.083	0.092	0.618	0.510	-0.142	2.181	2.090	-0.722

Data presented are in inches

Finally according to the present test, the table below shows the percentage of shots that would fall within the suggested NRA error standard of 0.25”:

PERCENTAGE OF SHOTS MEETING NRA ERROR STANDARD

	HEXTA	SOLO
1000YD	92.0	28.0
800YD	95.0	55.0
600YD	97.2	52.8

A graphic display of error for each shot at the three distances is given in Appendix D

Notice that no results for the ShotMarker were shown. There are several reasons for their absence. It was noticed that the errors for ShotMarker were much larger than previous tests. Figure 1 shows that the ShotMarker sensors are placed outside and slightly behind the SOLO sensors. The SOLO sensors and A-frame uprights may be interfering with the signal (bullet shock wave) reception with the ShotMarker sensors. Also at the 1000yd test, the ShotMarker did not record the last 5 shots. After the completion of the 1000yd test, we noticed that the ShotMarker hub had a blinking light indicating a problem which was a cable not being fully inserted into its socket. Furthermore, ShotMarker data analysis showed a malfunctioning rear upper left sensor so no quality values were recorded. More bad luck dogged ShotMarker for the 800yd test, no shots were recorded. During the installations of the grid paper for the test, a ShotMarker cable was accidently pulled from the hub.

Previous tests have shown that ShotMarker shot location accuracy are similar to that of SOLO.

Appendix A shows the plots comparing HEXTA and SOLO

Appendix B has the Excel files with the original data.

Appendix C has the wind data recorded during the test.

Appendix D shows the error magnitude for each shot

CONCLUSIONS

1. HEXTA is more accurate at shot location determination than SOLO.
2. Both systems' accuracy degrade with distance from the target but SOLO degrades faster (see Table 1).
3. Both systems accuracy do not generally degrade with target offset angle but there is a anomaly in SOLO error variability (SD).
4. **A word of caution: this test is not a definitive test. It can only be considered as a sample point with one set of etarget systems, an example of test procedure, and as an encouragement for further testing by other users of etargets**

RECOMMENDATIONS

This test was conducted under tight time constraints. Several interruptions occurred during the morning with range maintenance since the range was not reserved exclusively for the test. The test began during the early afternoon. We were given the impression that a match was scheduled for 5pm so we needed to complete the test in 4 hours. Because of this time constraints mistakes were made and the problem with the ShotMarker was one instance of problems due to rushing the test.

1. A debatably better method of correcting the etarget shot locations would be to use the calibration shots only for all distances
2. This test should be redone with a fully-functioning ShotMarker.
3. More shots should be made in the center of the target to increase the significance of the statistics since most shots are made in the center during a match. As a defense of our uniform shot distribution method, the Rattlesnake range is notorious for constant and quickly changing winds so shots can end in a wide pattern including vertically because of the gully between firing and targets lines.
4. The Australians have shown that open etargets are sensitive to the type of cartridge because of bullet energy so a variety of cartridges should be tested.
5. Some etarget users/vendors have said that wind can influence the performance of open etargets. This test was done under moderate to strong winds. A further test should be done with more moderate or low winds.

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FIGURE 1-TEST SETUP

FIGURE 2-HEXA TARGET AND A-FRAME

FIGURE 3-FIRING LINE SETUP

APPENDIX A-SHOT PLOTS

600yd plot.pdf

800yd plot.pdf

1000yd plot.pdf

APPENDIX B-TEST DATA FILES

600yd-measurementsOnly.pdf 800yd-measurementsOnly.pdf 1000yd-measurementsOnly.pdf

APPENDIX C-WIND PLOTS

There has been discussion by the Highpower community on the effect of wind on etarget accuracy. This test could not measure this effect since we did not have the time to wait for a low wind day. This wind data is only presented to those curious as to the wind conditions during the test.

The wind plots contained in the pdf files below show wind direction based on true North. The range faces approximately 16.9 degrees east of true north as can be seen in the figure below:

Rattlesnake Highpower Range

600yd wind plot.pdf 800yd wind plot.pdf 1000yd wind plot.pdf

APPENDIX D-SHOT ERROR PLOTS

600yd-NRA Criterion.pdf

800yd-NRA Criterion.pdf

1000yd-NRA Criterion.pdf