20/20 GateGuard Product Specification for 20' Roads
Viper Base Station (10 Channel)
Wednesday, January 27, 2010, Visible Assets Inc. Version 1-6

Purpose:

To validate design of a RuBee (IEEE 1902.1) asset and human presence detection product (GateGuard) that discovers ID tags and detects assets, in a vehicle, including assets that may be hidden in a vehicle. The GateGuard system has been modified from the standard 9' wide road, five channel Viper system to a ten channel Viper Base Station for vehicles driving through a 20' wide road at 5-7 km/h. Technical tests of the ten channel Viper Base Station and RuBee antenna system are also required.

Customer Specification requires Discovery of five (5) RuBee ID tags and simultaneous Detection of any unauthorized hidden assets in a moving vehicle at 5-7 km/h.

Background:

An international military customer has a high security facility with approximately 7,000 weapons in storage. Many (4,000) exit/entries occur each day where ID cards and legal weapons are carried into, and out of the facility. The facility has eight (8) two lane gates where a vehicle (Car, Truck, SUV, or Bus) might enter or exit the facility. Each gate has a stop with a gate barrier arm and some (five) with a sentry guardhouse.

This system requirement is to Discover up to five (5) personnel ID tags, and simultaneously Detection of the presence of any illegal, hidden or smuggled weapons within the vehicle (most important requirement). On occasion legal approved weapons may enter or exit the facility, however they maybe detected with a ping from a table kept in the GateGuard controller. These approved weapons are rare events with only about 3-4 per day.

Methods:

Data was collected using a 10 channel Viper Base Station driving seven (7) strategically positioned RuBee loop antennas. The antenna design (Figure 2) consists of four (4) drive thru antennas at 20' H x 21.5' W, two (2) side antennas at 8' H x 32' W, and one (1) optimized ground antenna at 32' Front x 16' Rear x 21.5' Side x 21.5' Side. These drive through antennas have the ability to be raised and lowered in case vehicles are taller than 20' as well as for any required maintenance. The ten channel Viper Base Station (Figure 4) used Clip multiplexed version 1.6 (Figure 3) and data logging was used for all results. The Viper Base Station was configured to run all seven (7) antennas simultaneously. Two (2) drive thru, two (2) side, and one (1) ground antennas were configured to transmit and receive, whereas two (2) drive thru antennas were set to receive only.

A combination of Gen2 ID Badges, Weapon, and Asset Tags (Figure 5) were positioned in the center of the seat and tested in all three (3) spatial planes. The test protocol consisted of 15 runs with tags placed at X, Y and Z planes at a speed of 5-7 km/h. In the first set of five (5) runs, the system operated in Discovery mode. The second set of five (5) runs, the system operated in Discovery + Detection of unauthorized assets mode. There were no hidden weapons in this set of tests. In the third set of five (5) runs, the system operated in Discovery + Detection of unauthorized assets, and a hidden weapon was placed in random locations throughout the vehicle (Engine Block, Trunk, Wheel Well, Under Seat, Aluminum Case in Trunk). The final test consisted of fifteen (15) runs at 5-7 km/h using ten (10) randomly placed IDs and weapon tags throughout the vehicle using Discovery only (7 runs) and Discovery + Detection of unauthorized assets (8 runs). The test vehicle was a 2007 Mercedes Benz S500, which was driven through the middle, left side, right side, diagonal left to right, and diagonal right to left paths.

Results:

The RuBee tags were Discovered and Detected at each of the five (5) positions in the vehicle with each tag oriented in all three (3) spatial planes (X, Y, Z). Figure 6 details the final test results for all 60 total runs and the corresponding graphical analysis can be found in Figure 7. In the first 15 runs, the tags were oriented in the Y plane in the center of each seat. The protocol called for Discovery of the five (5) tags and this was carried out for five (5) runs. Accuracy proved 25/25 or 100% for tag Discovery. Next, the system was configured to Discover the five (5) tags and Detect unauthorized weapons at the same time. No unauthorized weapons were placed in the vehicle, in order to ensure that no "false positives" would be detected. Accuracy proved 25/25 or 100% for tag Discovery and 0/5 or 0% for unauthorized weapon Detection (no false positives). Then an unauthorized weapon was hidden inside the vehicle. Accuracy proved 25/25 or 100% for tag Discovery and 5/5 or 100% for Detection of unauthorized weapon Detection (no false negatives).

In the next set of 15 runs, the tags were oriented in the X plane at the same location in the vehicle. The protocol called for Discovery of the five (5) tags and this was carried out for five (5) runs. Accuracy proved 25/25 or 100% for tag Discovery. Next, the system was configured to Discover the five (5) tags and Detect unauthorized weapons at the same time. No unauthorized weapons were placed in the vehicle. Accuracy proved 25/25 or 100% for tag Discovery and 0/5 or 0% for unauthorized weapon Detection (no false positives). Then, an unauthorized weapon was hidden inside the vehicle. Accuracy proved 25/25 or 100% for the tag Discovery and 5/5 or 100% for unauthorized weapon Detection (no false negatives).

In the next set of 15 runs, the tags were oriented in the Z plane at the same location in the vehicle. The protocol called for Discovery of the five (5) tags and this was carried out for five (5) runs. Accuracy proved 25/25 or 100% for tag Discovery. Next, the system was configured to Discover the five (5) tags and Detect unauthorized weapons at the same time. No unauthorized weapons were placed in the vehicle. Accuracy proved 25/25 or 100% for tag Discovery and 0/5 or 0% for unauthorized weapon Detection (no false positives). Then an unauthorized weapon was hidden inside the vehicle. Accuracy proved 25/25 or 100% for tag Discovery and 5/5 or 100% for unauthorized weapon Detection (no false negatives).

Data for 45 total runs are summarized in table below.

Tag Orientation	Discovery	Accuracy	Detection	Accuracy	All Events	Accuracy
Coplanar Y	75/75	100%	10/10	100%	85/85	100%
Coplanar X	75/75	100%	10/10	100%	85/85	100%
Coplanar Z	75/75	100%	10/10	100%	85/85	100%

As a final safety test we increased the number of tags by 2 times over the original specification from five to ten (10) ID tags. Ten ID tags were randomly placed throughout the vehicle. The protocol called for Discovery of all ten (10) tags and this was carried out for seven (7) runs. Accuracy proved 69/70 or 98.5% for tag Discovery. Next, the system was configured to Discover the ten (10) tags and Detect unauthorized weapons at the same time. No unauthorized weapons were placed in the vehicle. Accuracy proved 77/80 or 96.3% for tag Discovery and 0/8 or 0% for unauthorized weapon Detection.

Conclusion:

GateGuard 20/20 reliably (100% in 255 trials) discovers 5 RuBee ID tags placed at any angle inside a vehicle moving at 5-7 km/h on a 20 foot wide road. It also reliably detects the presence of any unauthorized weapons under the same conditions. This Detection is simultaneous with Discovery of the ID tags. The system operates at 50% above the required levels, with the ability to reliably discover and detect up to 8-10 tags, including detection of unauthorized weapons.

Technical performance and operation of the 10 channel Viper with a large array of independent antennas has been validated.

As per customer specification GateGuard 20/20 discovers five (5) RuBee tags and detect unauthorized assets in a moving vehicle at a speed of 5-7 km/h as they pass into and out of a secure facility on roads from 9’ to 20’ wide. The drive through antenna design offers ability to raise and lower antennas for large vehicles higher than 20’.

No other wireless technology is capable of either Discovery or Detection of tags inside of a moving vehicle. Moreover, no other wireless technology can detect tags without angle sensitivity. RuBee is able to uniquely provide all three (Discovery, Detection with No Angle Sensitivity) in a moving vehicle, because of “RuBee physics”. RuBee uses 131Khz signals in the near field and is able to synchronize the transmit and receive signals, simultaneously in many antennas, with phase correction and power compensation. The sensitivity seen in this study on Detection is very high, in all cases with signal strength in the 1,000 plus signal units. This study shows that this sensitivity translates into a reliable, noise immune Discovery and Detection system.

Figure 1 – 20/20 GateGuard Prototype

Front View

Front View_2

Close Up of Ground Loops

Close Up of Drive Thru – Note pulleys make it possible to lower antennas.

Figure 2 – 20/20 GateGuard Antenna Configuration

Top View

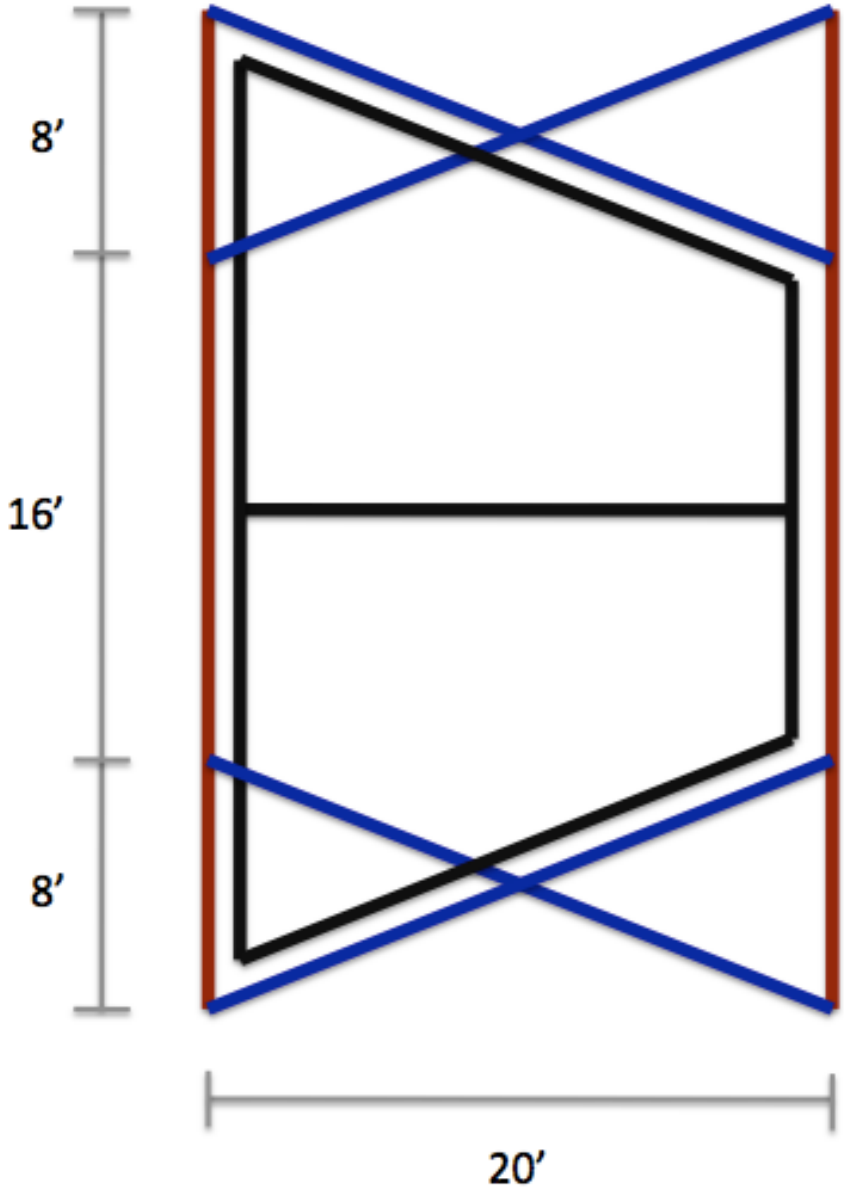
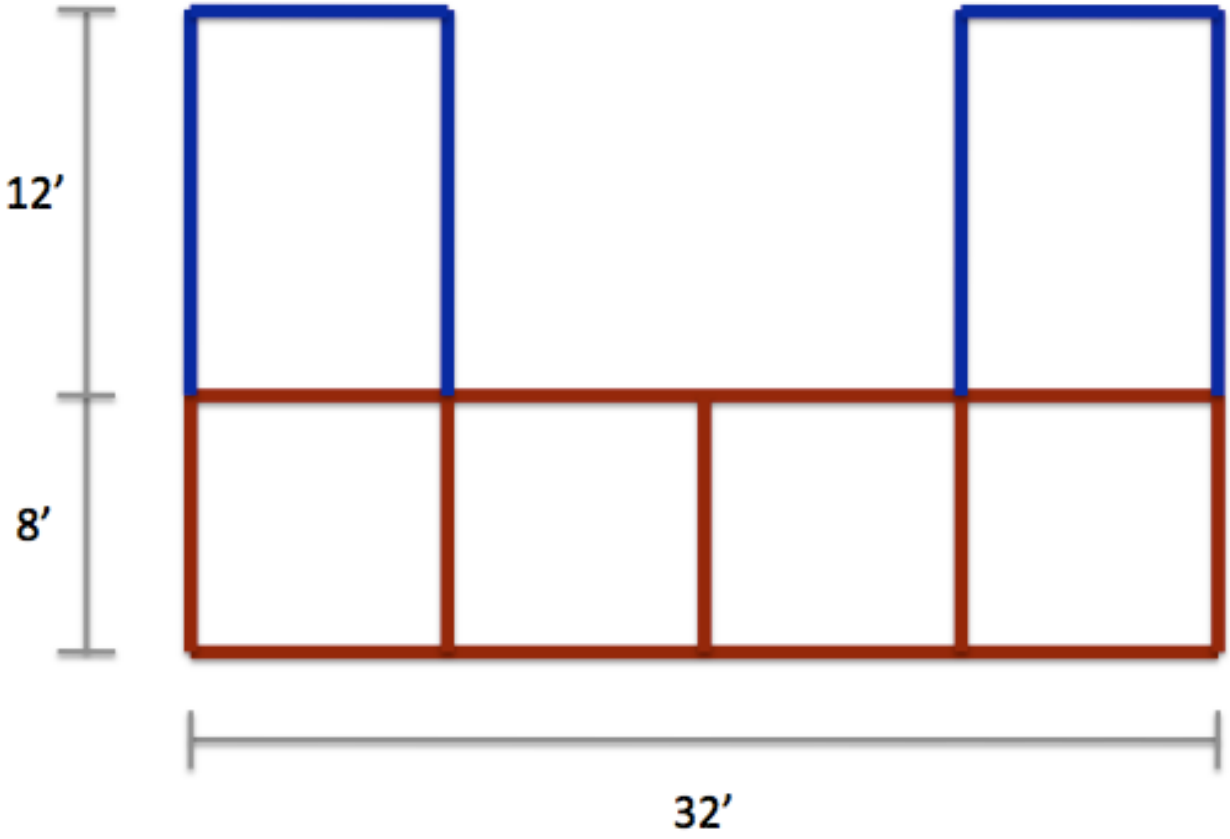


Figure 2 – 20/20 GateGuard Antenna Configuration

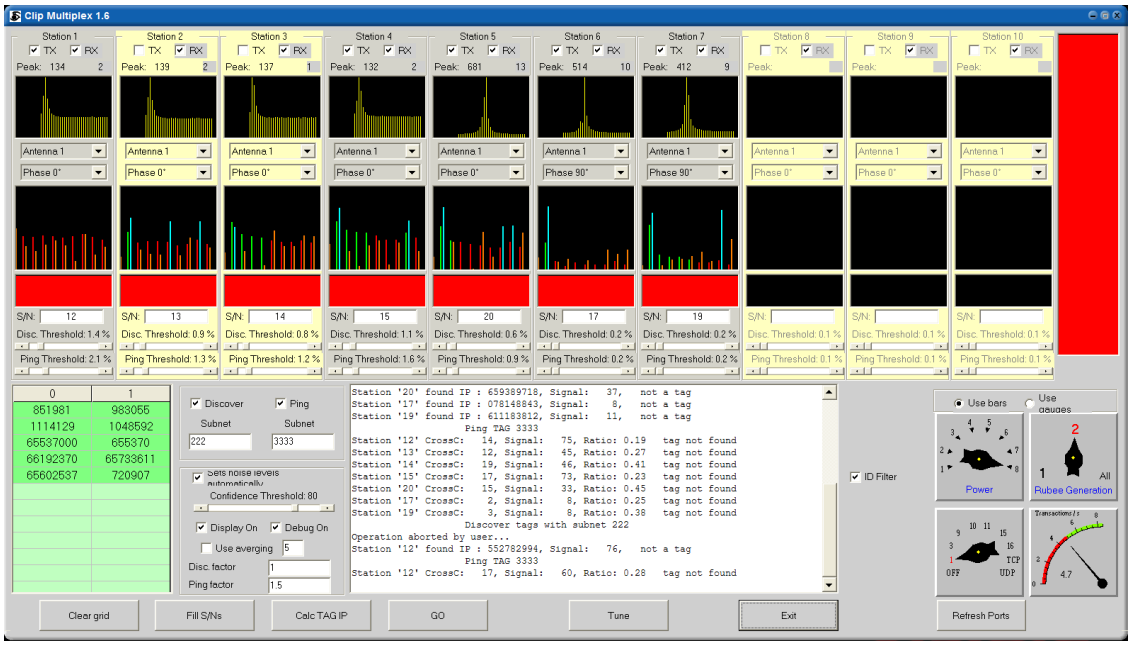
Side View



Legend

Blue – Drive Thru Antennas
Red – Side Antennas
Black – Ground Antennas

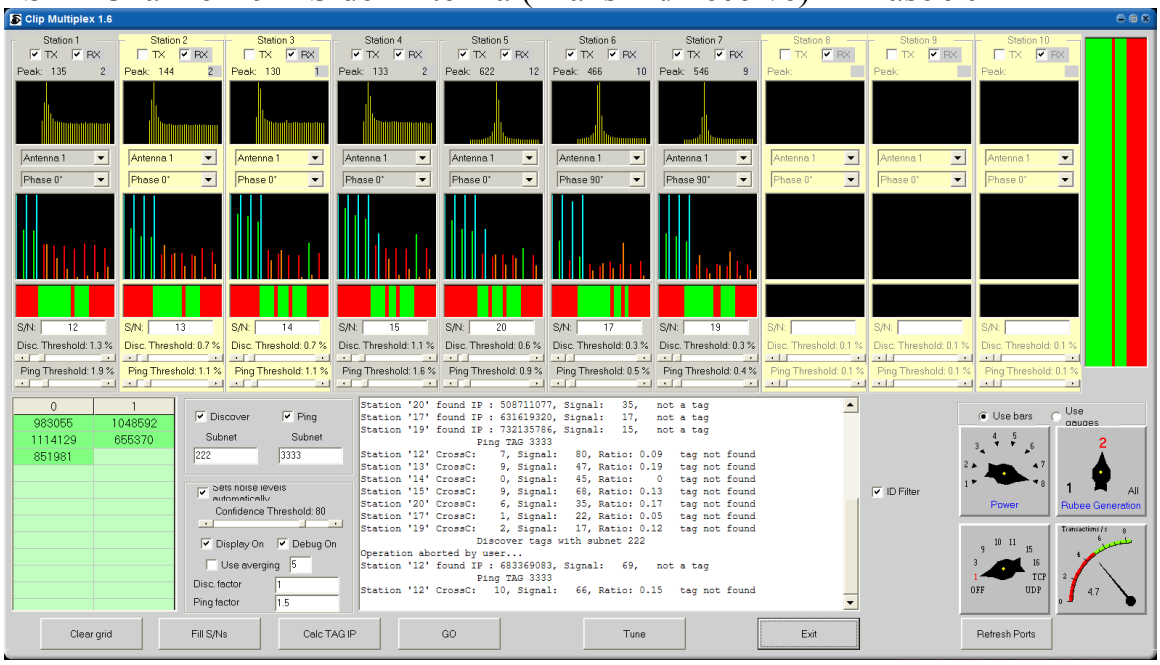
Figure 3 – Clip Multiplex 1.6



10 Tags Discovered (Green #'s) & No Unauthorized Weapons Detected (Red Bars)

ANTENNA CONFIGURATION

BS1 - Channel 12 – Drive Thru Antenna (Transmit/Receive) – Phase 0º
BS2 - Channel 13 – Drive Thru Antenna (Receive Only) – Phase 0º
BS3 - Channel 14 – Drive Thru Antenna (Receive Only) – Phase 0º
BS4 - Channel 15 – Drive Thru Antenna (Transmit/Receive) – Phase 0º
BS5 – Channel 20 – Ground Antenna (Transmit/Receive) – Phase 0º
BS6 – Channel 17 – Side Antenna (Transmit/Receive) – Phase 90º
BS7 – Channel 19 – Side Antenna (Transmit/Receive) – Phase 90º



5 Tags Discovered (Green #'s) & Unauthorized Weapon Detected (Green Bars)

Figure 4 – Viper Base Station (10 Channel)

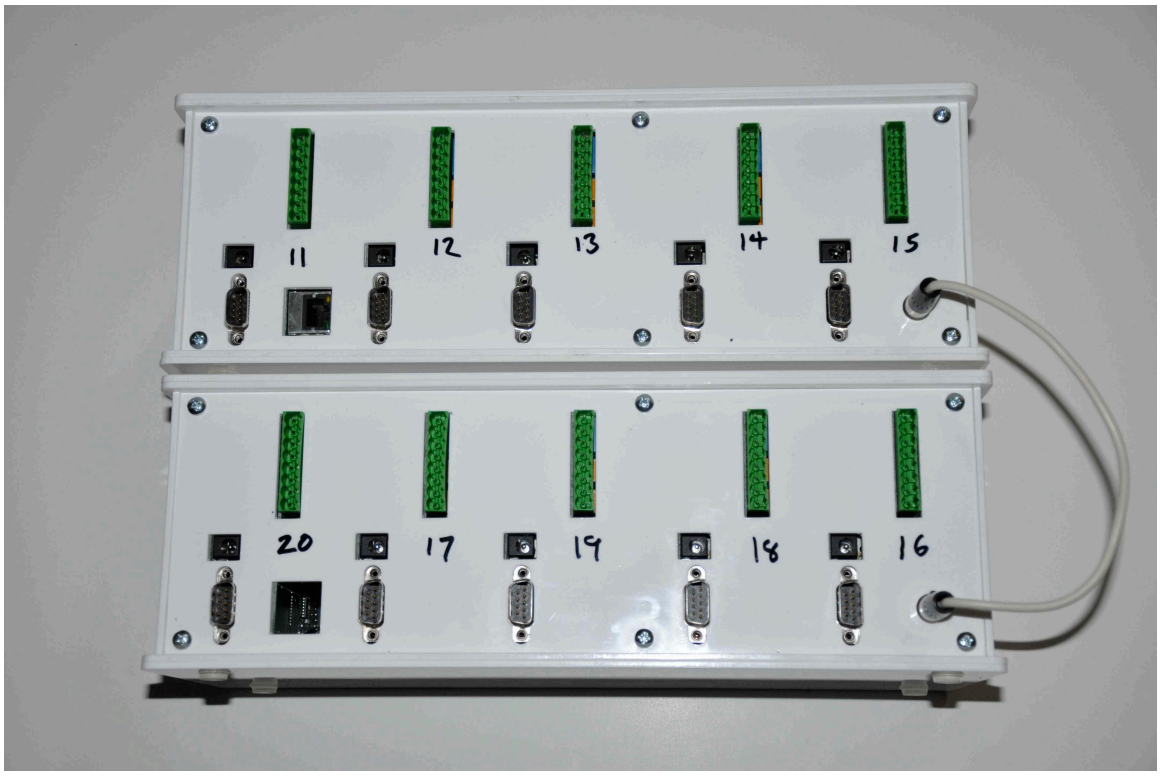


Figure 5 – RuBee Tags (ID Badges, Weapon Tags, Asset Tags)

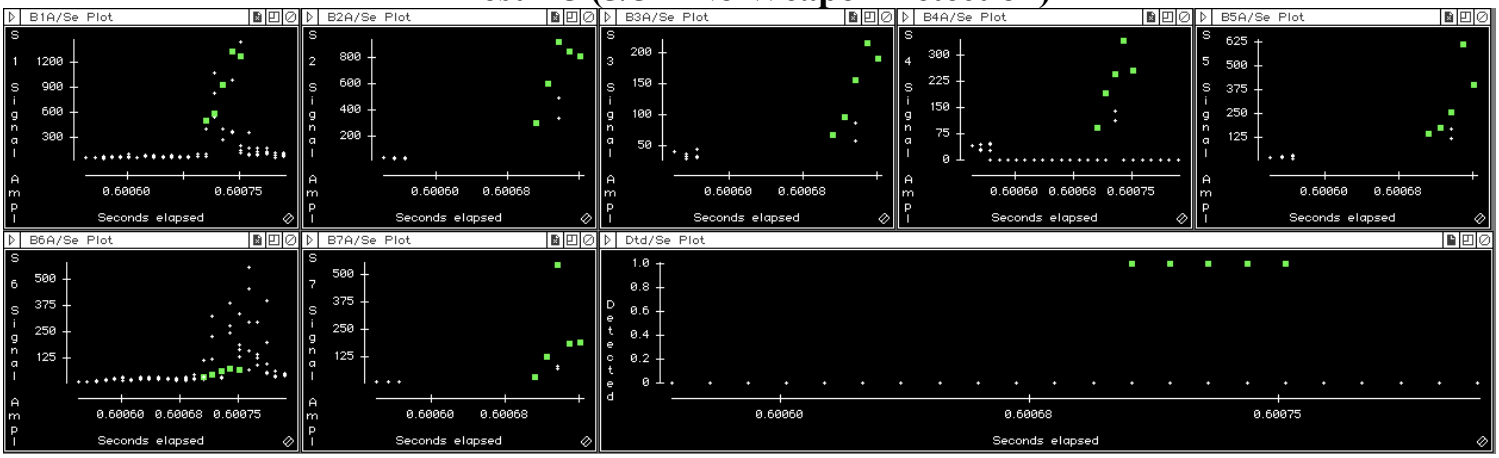
Figure 6 – Final Test Results

Test #	Protocol	Accuracy	Weapon Detection	Tag Orientation	Vehicle Speed	Vehicle Path
1	Discovery Only	**5/5**	No	Coplanar Y	5-7 km/h	Center
2	Discovery Only	**5/5**	No	Coplanar Y	5-7 km/h	Left
3	Discovery Only	**5/5**	No	Coplanar Y	5-7 km/h	Right
4	Discovery Only	**5/5**	No	Coplanar Y	5-7 km/h	Diagonal L to R
5	Discovery Only	**5/5**	No	Coplanar Y	5-7 km/h	Diagonal R to L
6	Discovery + Detection	**5/5**	No	Coplanar Y	5-7 km/h	Center
7	Discovery + Detection	**5/5**	No	Coplanar Y	5-7 km/h	Left
8	Discovery + Detection	**5/5**	No	Coplanar Y	5-7 km/h	Right
9	Discovery + Detection	**5/5**	No	Coplanar Y	5-7 km/h	Diagonal L to R
10	Discovery + Detection	**5/5**	No	Coplanar Y	5-7 km/h	Diagonal R to L
11	Discovery + Detection	**5/5**	Yes	Coplanar Y	5-7 km/h	Center
12	Discovery + Detection	**5/5**	Yes	Coplanar Y	5-7 km/h	Left
13	Discovery + Detection	**5/5**	Yes	Coplanar Y	5-7 km/h	Right
14	Discovery + Detection	**5/5**	Yes	Coplanar Y	5-7 km/h	Diagonal L to R
15	Discovery + Detection	**5/5**	Yes	Coplanar Y	5-7 km/h	Diagonal R to L
16	Discovery + Detection	**5/5**	Yes	Coplanar X	5-7 km/h	Center
17	Discovery + Detection	**5/5**	Yes	Coplanar X	5-7 km/h	Left
18	Discovery + Detection	**5/5**	Yes	Coplanar X	5-7 km/h	Right
19	Discovery + Detection	**5/5**	Yes	Coplanar X	5-7 km/h	Diagonal L to R
20	Discovery + Detection	**5/5**	Yes	Coplanar X	5-7 km/h	Diagonal R to L
21	Discovery + Detection	**5/5**	No	Coplanar X	5-7 km/h	Center
22	Discovery + Detection	**5/5**	No	Coplanar X	5-7 km/h	Left
23	Discovery + Detection	**5/5**	No	Coplanar X	5-7 km/h	Right
24	Discovery + Detection	**5/5**	No	Coplanar X	5-7 km/h	Diagonal L to R
25	Discovery + Detection	**5/5**	No	Coplanar X	5-7 km/h	Diagonal R to L
26	Discovery Only	**5/5**	No	Coplanar X	5-7 km/h	Center
27	Discovery Only	**5/5**	No	Coplanar X	5-7 km/h	Left
28	Discovery Only	**5/5**	No	Coplanar X	5-7 km/h	Right
29	Discovery Only	**5/5**	No	Coplanar X	5-7 km/h	Diagonal L to R
30	Discovery Only	**5/5**	No	Coplanar X	5-7 km/h	Diagonal R to L
31	Discovery Only	**5/5**	No	Coplanar Z	5-7 km/h	Center
32	Discovery Only	**5/5**	No	Coplanar Z	5-7 km/h	Left
33	Discovery Only	**5/5**	No	Coplanar Z	5-7 km/h	Right
34	Discovery Only	**5/5**	No	Coplanar Z	5-7 km/h	Diagonal L to R
35	Discovery Only	**5/5**	No	Coplanar Z	5-7 km/h	Diagonal R to L
36	Discovery + Detection	**5/5**	No	Coplanar Z	5-7 km/h	Center
37	Discovery + Detection	**5/5**	No	Coplanar Z	5-7 km/h	Left
38	Discovery + Detection	**5/5**	No	Coplanar Z	5-7 km/h	Right
39	Discovery + Detection	**5/5**	No	Coplanar Z	5-7 km/h	Diagonal L to R
40	Discovery + Detection	**5/5**	No	Coplanar Z	5-7 km/h	Diagonal R to L
41	Discovery + Detection	**5/5**	Yes	Coplanar Z	5-7 km/h	Center
42	Discovery + Detection	**5/5**	Yes	Coplanar Z	5-7 km/h	Left
43	Discovery + Detection	**5/5**	Yes	Coplanar Z	5-7 km/h	Right
44	Discovery + Detection	**5/5**	Yes	Coplanar Z	5-7 km/h	Diagonal L to R
45	Discovery + Detection	**5/5**	Yes	Coplanar Z	5-7 km/h	Diagonal R to L
46	Discovery Only	**10/10**	No	Random Placement	5-7 km/h	Center
47	Discovery Only	**10/10**	No	Random Placement	5-7 km/h	Left
48	Discovery Only	**10/10**	No	Random Placement	5-7 km/h	Right
49	Discovery Only	**10/10**	No	Random Placement	5-7 km/h	Diagonal L to R
50	Discovery Only	**9/10**	No	Random Placement	5-7 km/h	Diagonal R to L
51	Discovery Only	**10/10**	No	Random Placement	5-7 km/h	Center
52	Discovery Only	**10/10**	No	Random Placement	5-7 km/h	Left
53	Discovery + Detection	**8/10**	No	Random Placement	5-7 km/h	Right
54	Discovery + Detection	**10/10**	No	Random Placement	5-7 km/h	Diagonal L to R
55	Discovery + Detection	**10/10**	No	Random Placement	5-7 km/h	Diagonal R to L
56	Discovery + Detection	**10/10**	No	Random Placement	5-7 km/h	Center
57	Discovery + Detection	**10/10**	No	Random Placement	5-7 km/h	Left
58	Discovery + Detection	**10/10**	No	Random Placement	5-7 km/h	Right
59	Discovery + Detection	**9/10**	No	Random Placement	5-7 km/h	Diagonal L to R
60	Discovery + Detection	**10/10**	No	Random Placement	5-7 km/h	Diagonal R to L

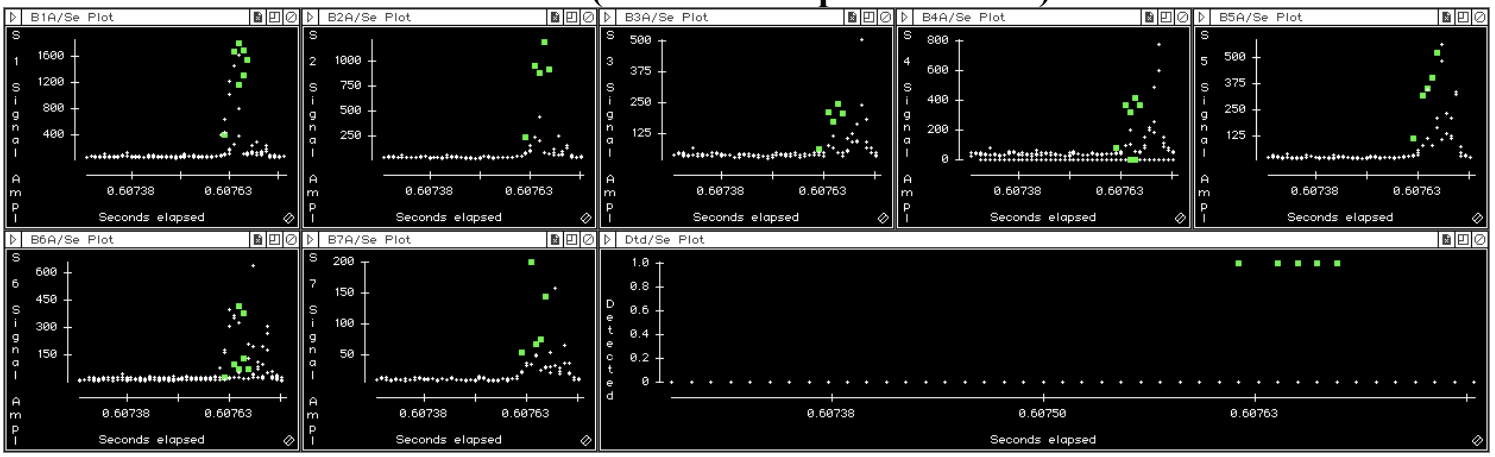
Figure 7 – Signal vs. Time Graphs

1 of 5 tests selected (random) for each set of runs at each spatial plane tested.
1st seven (7) graphs represent each antenna's signal amplitude vs. time
Last graph is Tag Found graph (green dot means successful discovery or detection)

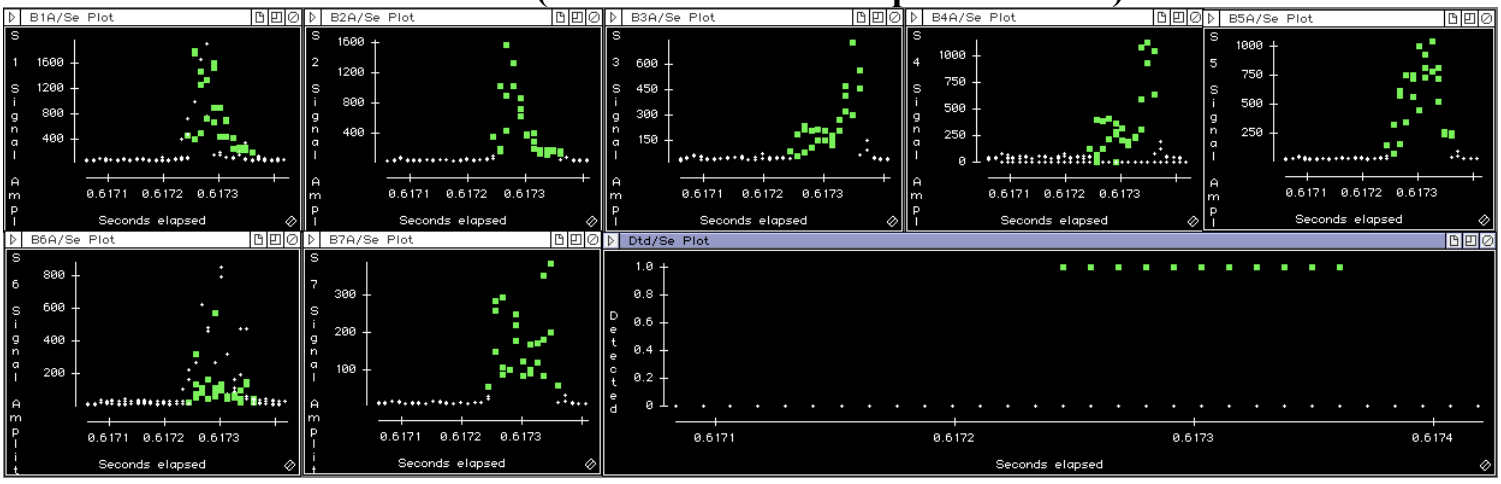
Test # 5 (5/5 + No Weapon Detection)



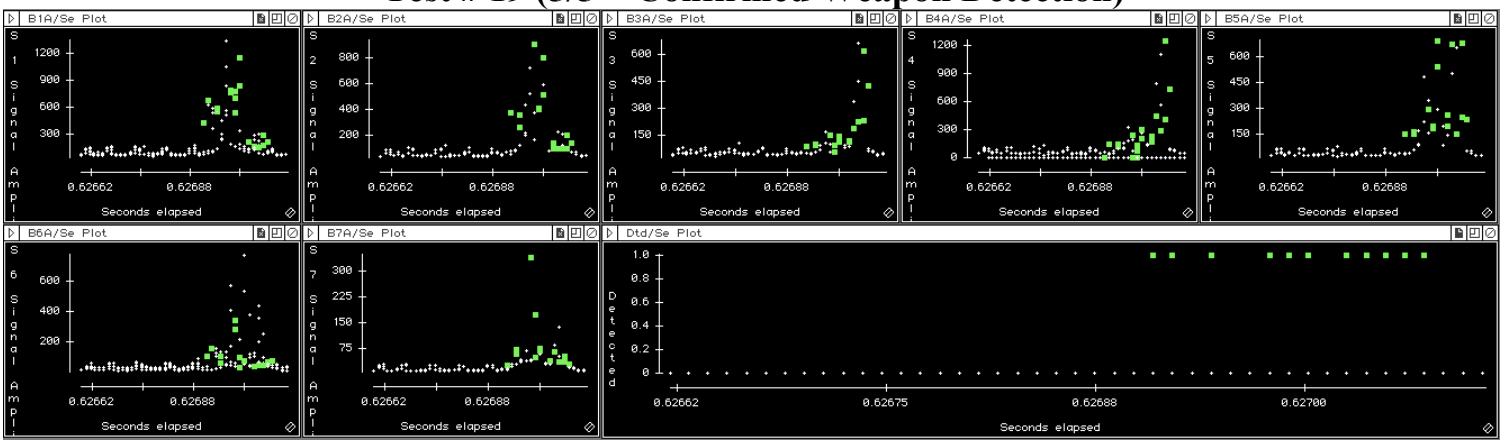
Test # 8 (5/5 + No Weapon Detection)



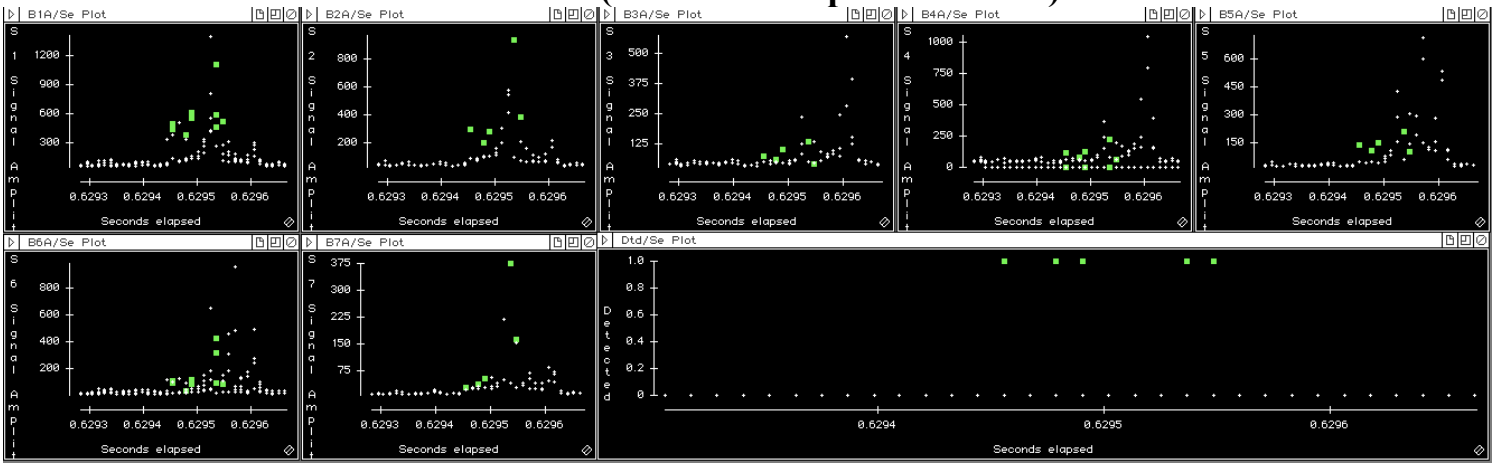
Test # 15 (5/5 + Confirmed Weapon Detection)



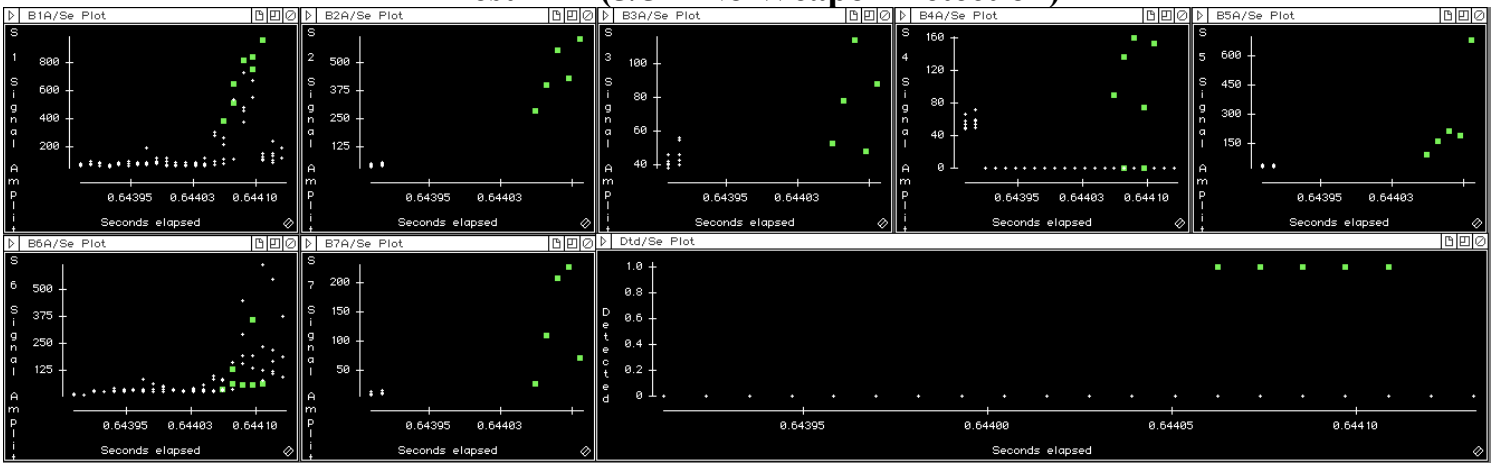
Test # 19 (5/5 + Confirmed Weapon Detection)



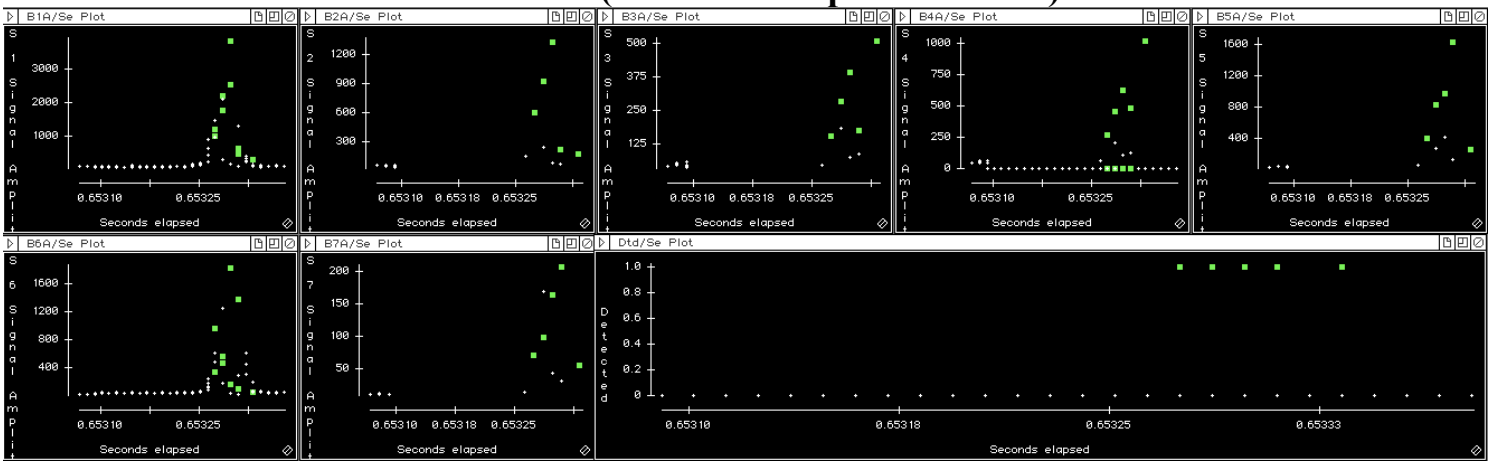
Test # 21 (5/5 + No Weapon Detection)



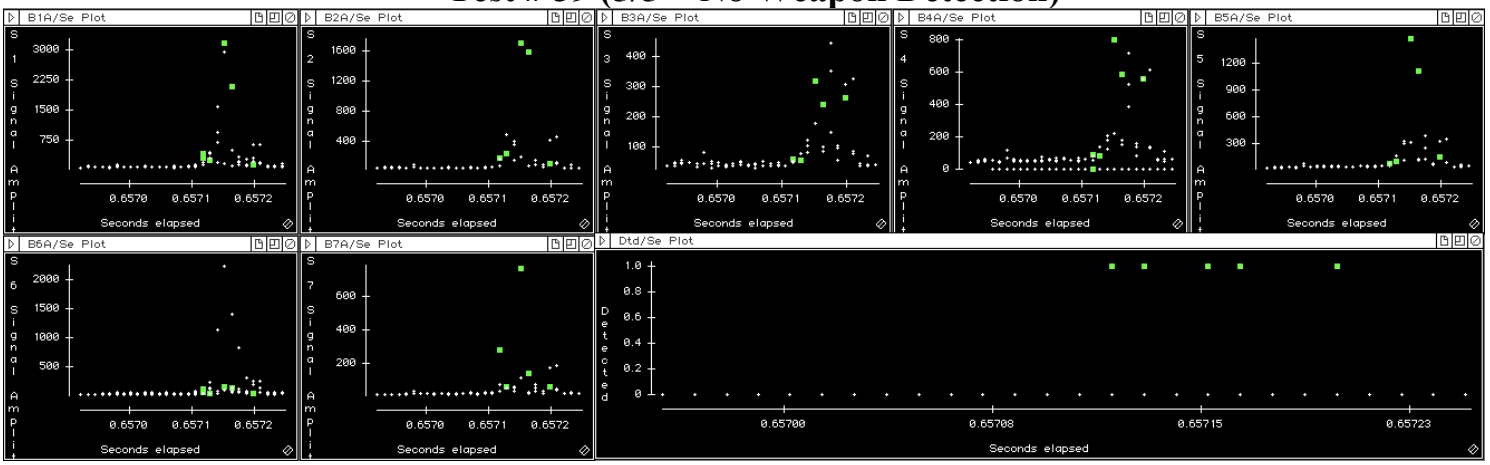
Test # 27 (5/5 + No Weapon Detection)



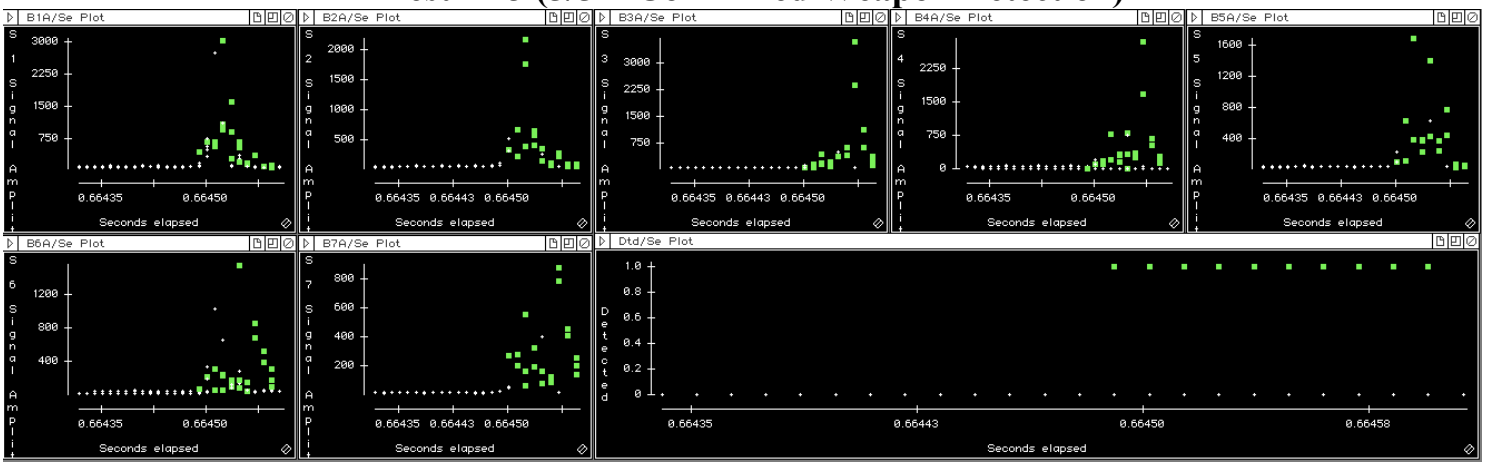
Test # 35 (5/5 + No Weapon Detection)



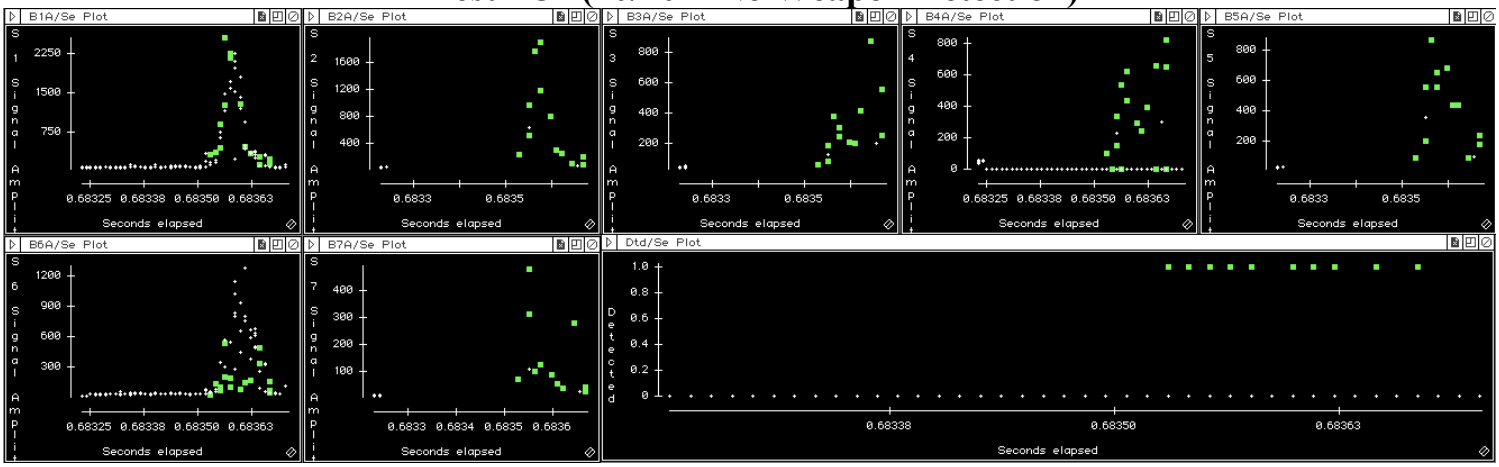
Test # 39 (5/5 + No Weapon Detection)



Test # 43 (5/5 + Confirmed Weapon Detection)



Test # 51 (10/10 + No Weapon Detection)



Document Control

Document Status

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Revision Control and History

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Report	TMP	January 28, 2010	1.2
Review	JKS, CW, JA	January 29, 2010	1.6

Signatures