



## Shooting Reconstruction - Angle Determination Test No. 18-5620 Summary Report

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This test was sent to 113 participants. Each sample set contained a wooden box that consisted of one entrance hole, one exit hole and "TOP", "FRONT", and "BACK" labels to distinguish the orientation of the box. In addition, one "A" label was placed on the front and one "I" label was placed on the back of the box to assist participants when reporting the entrance/exit holes and direction of travel. Participants were requested to determine the character associated with the entrance hole, the direction of travel and calculate the angles. Data were returned from 90 participants and are compiled into the following tables:

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This report contains the data received from the participants in this test. Since these participants are located in many countries around the world, and it is their option how the samples are to be used (e.g., training exercise, known or blind proficiency testing, research and development of new techniques, etc.), the results compiled in the Summary Report are not intended to be an overview of the quality of work performed in the profession and cannot be interpreted as such. The Summary Comments are included for the benefit of participants to assist with maintaining or enhancing the quality of their results. These comments are not intended to reflect the general state of the art within the profession.

Participant results are reported using a randomly assigned "WebCode". This code maintains participant's anonymity, provides linking of the various report sections, and will change with every report.

## **Manufacturer's Information**

Each sample set contained a wooden box that consisted of one entrance hole, one exit hole and "TOP", "FRONT", and "BACK" labels to distinguish the orientation of the box. In addition, one "A" label was placed on the front and one "1" label was placed on the back of the box to assist participants when reporting the entrance/exit holes and direction of travel. Participants were requested to determine the character associated with the entrance hole, the direction of travel and calculate the angles. The front of the box containing the "A" label was associated with the entrance hole and the direction of travel was left to right, upward. The angles as measured during production are described below.

PRODUCTION: The sample was placed onto a fixed angle set up (jig). A .22 LR Ruger MKIII firearm was affixed above the jig and a digital angle finder was placed on the jig to confirm the angle to be shot.

The Horizontal (Azimuth) angle was measured as 14°(from perpendicular), 76°(left to right) or 104°(right to left) and the Vertical angle was measured as 42.8°(upward) or 137.2°(downward).

SAMPLE SET ASSEMBLY: After each sample was shot, it was securely placed in a sample pack box. This process was repeated until all of the desired samples were produced.

VERIFICATION: All three predistribution laboratories reported Horizontal and Vertical angles within  $\pm 5^\circ$  from the expected responses.

## **Summary Comments**

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This test was designed to allow participants to assess their proficiency in shooting reconstruction, with a focus on angle determination. Each sample set consisted of a wooden box (Item 1) containing an entrance and exit hole. The wooden box was designated with "TOP", "FRONT", and "BACK" labels to assist participants with the orientation of the sample. In addition, one "A" label was placed on the front and one "1" label was placed on the back of the box to assist participants when reporting the entrance/exit holes and direction of travel. [Refer to Manufacturer's Information for preparation details.]

ENTRANCE HOLE: All 90 participants identified "A" as being the side containing the entrance hole.

DIRECTIONALITY: Of the 90 participants, 88 reported a left to right direction and two participants reported a right to left direction. In regards to upward/downward directionality, all 90 participants reported an upward direction.

ANGLE DETERMINATION:

### **HORIZONTAL**

Any reported horizontal angles that fell outside ranges  $9^{\circ}$ - $19^{\circ}$  (from perpendicular),  $71^{\circ}$ - $81^{\circ}$  (left to right) and  $99^{\circ}$ - $109^{\circ}$  (right to left) were highlighted as inconsistent. These ranges were determined by using a factor of  $\pm 5^{\circ}$  from the expected response.

Of the 75 participants that reported horizontal angles, 49 (65%) reported angles ranging from  $71^{\circ}$  to  $81^{\circ}$  (left to right), 14 (19%) reported angles ranging from  $9^{\circ}$  to  $19^{\circ}$  (perpendicular) and four (5%) reported angles ranging from  $99^{\circ}$  to  $109^{\circ}$  (right to left). Eight participants reported angles that did not fall within  $\pm 5^{\circ}$  from the expected response.

### **VERTICAL**

Any reported vertical angles that fell outside ranges  $38^{\circ}$ - $48^{\circ}$  (upward) and  $132^{\circ}$ - $142^{\circ}$  (downward) were highlighted as inconsistent. These ranges were determined by using a factor of  $\pm 5^{\circ}$  from the expected response.

Of the 75 participants that reported vertical angles, 67 (89%) reported angles ranging from  $38^{\circ}$  to  $48^{\circ}$  (upward) and three (4%) reported angles ranging from  $132^{\circ}$  to  $142^{\circ}$  (downward). Five participants reported angles that did not fall within  $\pm 5^{\circ}$  from the expected response.

Fifteen participants did not report any angles. CTS is aware that some labs will report directionality only and will not report any angle measurements. In addition, three participants reported angles, but it appears as if they measured the horizontal angle, but reported it as a vertical angle and vice versa.

# Entrance Hole

Which label on the box represents the entrance hole?

TABLE 1

WebCode	Entrance Designation	WebCode	Entrance Designation
2249HK	A	DHRHA4	A
2TBVK7	A	E2GQX7	A
36XMKZ	A	E7EHEV	A
3FXM9K	A	EQHVB	A
3KCXLN	A	ERCGQF	A
3UFFV7	A	F3QXXD	A
4396TL	A	FEJEME	A
462AX8	A	G29WD4	A
6JP2VD	A	G37897	A
6T2VD2	A	G6ERB9	A
74YQYH	A	G77MXG	A
7YJHBH	A	GV3V72	A
82KBUZ	A	H3YEUV	A
8GWGUL	A	HK3UFV	A
8LQLX4	A	HTUYY4	A
8RY8L2	A	JNYXKM	A
8YX4KK	A	K8N774	A
8ZRT4F	A	KFKCBJ	A
9LNFUE	A	KVAJ7W	A
9M2F6B	A	LDNHNY	A
ADBRBK	A	LE2E86	A
AE3CCX	A	LFV3Q2	A
ATNPRE	A	LKRQ6M	A
AXB8UA	A	LMYEVQ	A
AZ2798	A	LPZCWQ	A
B7MJMZ	A	LR839T	A
B9PGXT	A	MHYHCW	A
BAMRTW	A	NA3AFP	A
CC6D2A	A	NBEGUY	A
D23BDR	A	NC83AN	A
D9HJQA	A	ND4FWG	A
DETEVJ	A		

WebCode	Entrance Designation	WebCode	Entrance Designation
NF97YP	A		
NG6UT2	A		
NJ9MMZ	A		
NYG9YF	A		
PETey2	A		
PHTM7W	A		
PHVCAT	A		
Q6VVKV	A		
R83ZNQ	A		
R9XWKT	A		
RH32BN	A		
T28XAB	A		
T2BKLH	A		
T397P4	A		
TRNLVC	A		
TZEAQE	A		
UKA9AU	A		
UPWHQQ	A		
V8BNPL	A		
VJMJVR	A		
VML8LR	A		
X9EYW9	A		
XLN7MM	A		
XQF3YC	A		
YTKT2K	A		
YV6A8Q	A		
Z9AK2C	A		

Response Summary		Participants: 90
Which label on the box represents the entrance hole?		
Entrance Designation:	A	1
Participants:	90 (100%)	0 (0%)

## Direction of Travel

What is the direction of travel of the bullet through the box? (check all that applies)

TABLE 2

WebCode	Direction of Travel		
	Left / Right	Front / Back	Upward / Downward
2249HK	Left to Right	Front to Back	Upward
2TBVK7	Left to Right	Front to Back	Upward
36XMKZ	Left to Right	Front to Back	Upward
3FXM9K	Left to Right	Front to Back	Upward
3KCXLN	Left to Right	Front to Back	Upward
3UFFV7	Left to Right	Front to Back	Upward
4396TL	Left to Right	Front to Back	Upward
462AX8	Left to Right	Front to Back	Upward
6JP2VD	Left to Right	Front to Back	Upward
6T2VD2	Left to Right	Front to Back	Upward
74YQYH	Left to Right	Front to Back	Upward
7YJHBH	Left to Right	Front to Back	Upward
82KBUZ	Left to Right	Front to Back	Upward
8GWGUL	Left to Right	Front to Back	Upward
8LQLX4	Left to Right	Front to Back	Upward
8RY8L2	Left to Right	Front to Back	Upward
8YX4KK	Left to Right	Front to Back	Upward
8ZRT4F	Left to Right	Front to Back	Upward
9LNFUE	Left to Right	Front to Back	Upward
9M2F6B	Left to Right	Front to Back	Upward
ADRBK	Left to Right	Front to Back	Upward
AE3CCX	Right to Left	Front to Back	Upward
ATNPRE	Left to Right	Front to Back	Upward
AXB8UA	Left to Right	Front to Back	Upward
AZ2798	Left to Right	Front to Back	Upward
B7MJMZ	Left to Right	Front to Back	Upward
B9PGXT	Left to Right	Front to Back	Upward
BAMRTW	Left to Right	Front to Back	Upward
CC6D2A	Left to Right	Front to Back	Upward
D23BDR	Left to Right	Front to Back	Upward
D9HJQA	Left to Right	Front to Back	Upward
DETEVJ	Left to Right	Front to Back	Upward

TABLE 2

WebCode	Direction of Travel		
	Left / Right	Front / Back	Upward / Downward
DHRHA4	Left to Right	Front to Back	Upward
E2GQX7	Left to Right	Front to Back	Upward
E7EHEV	Left to Right	Front to Back	Upward
EQHVB	Left to Right	Front to Back	Upward
ERCGQF	Left to Right	Front to Back	Upward
F3QXXD	Left to Right	Front to Back	Upward
FEJEME	Left to Right	Front to Back	Upward
G29WD4	Left to Right	Front to Back	Upward
G37897	Left to Right	Front to Back	Upward
G6ERB9	Left to Right	Front to Back	Upward
G77MXG	Left to Right	Front to Back	Upward
GV3V72	Left to Right	Front to Back	Upward
H3YEUV	Left to Right	Front to Back	Upward
HK3UFV	Left to Right	Front to Back	Upward
HTUYY4	Left to Right	Front to Back	Upward
JNYXKM	Left to Right	Front to Back	Upward
K8N774	Left to Right	Front to Back	Upward
KFKCBJ	Left to Right	Front to Back	Upward
KVAJ7W	Left to Right	Front to Back	Upward
LDNHNY	Left to Right	Front to Back	Upward
LE2E86	Left to Right	Front to Back	Upward
LFV3Q2	Left to Right	Front to Back	Upward
LKRQ6M	Left to Right	Front to Back	Upward
LMYEVQ	Left to Right	Front to Back	Upward
LPZCWQ	Left to Right	Front to Back	Upward
LR839T	Left to Right	Front to Back	Upward
MHYHCW	Right to Left	Front to Back	Upward
NA3AFP	Left to Right	Front to Back	Upward
NBEGUY	Left to Right	Front to Back	Upward
NC83AN	Left to Right	Front to Back	Upward
ND4FWG	Left to Right	Front to Back	Upward
NF97YP	Left to Right	Front to Back	Upward
NG6UT2	Left to Right	Front to Back	Upward
NJ9MMZ	Left to Right	Front to Back	Upward
NYG9YF	Left to Right	Front to Back	Upward

TABLE 2

WebCode	Direction of Travel		
	Left / Right	Front / Back	Upward / Downward
PETAY2	Left to Right	Front to Back	Upward
PHTM7W	Left to Right	Front to Back	Upward
PHVCAT	Left to Right	Front to Back	Upward
Q6VVKV	Left to Right	Front to Back	Upward
R83ZLNQ	Left to Right	Front to Back	Upward
R9XWKT	Left to Right	Front to Back	Upward
RH32BN	Left to Right	Front to Back	Upward
T28XAB	Left to Right	Front to Back	Upward
T2BKLH	Left to Right	Front to Back	Upward
T397P4	Left to Right	Front to Back	Upward
TRNLVC	Left to Right	Front to Back	Upward
TZEAQE	Left to Right	Front to Back	Upward
UKA9AU	Left to Right	Front to Back	Upward
UPWHQQ	Left to Right	Front to Back	Upward
V8BNPL	Left to Right	Front to Back	Upward
VJMJVR	Left to Right	Front to Back	Upward
VML8LR	Left to Right	Front to Back	Upward
X9EYW9	Left to Right	Front to Back	Upward
XLN7MM	Left to Right	Front to Back	Upward
XQF3YC	Left to Right	Front to Back	Upward
YTKT2K	Left to Right	Front to Back	Upward
YV6A8Q	Left to Right	Front to Back	Upward
Z9AK2C	Left to Right	Front to Back	Upward

Response Summary			Participants: 90
What is the direction of travel of the bullet through the box?			
Left to Right: 88		Front to Back: 90	Upward: 90
Right to Left: 2		Back to Front: 0	Downward: 0



# Angles

TABLE 3 - Horizontal (Azimuth)

WebCode	Angle Measurement (degrees)	Uncertainty (degrees)
2249HK	79	5
2TBVK7	81	5
36XMKZ		
3FXM9K	42.5	
3KCXLN	80	5
3UFFV7	77	2
4396TL	10	5
462AX8		
6JP2VD	79	5
6T2VD2	81	5
74YQYH	7	2
7YJHBH	79.5	0.5
82KBUZ	82	5
8GWGUL	83	
8LQLX4		
8RY8L2	79	5
8YX4KK	11	5
8ZRT4F	9	3
9LNFUE	79	NA
9M2F6B	81	5
ADBRBK	9° from perpendicular	
AE3CCX	77	5
ATNPRE	81.1	2.3
AXB8UA	80	5
AZ2798	79.7	5
B7MJMZ		
B9PGXT		
BAMRTW	79.0	5
CC6D2A	100	5
D23BDR	77	5
D9HJQA	81	2
DETEVJ	80 Left-Right	5
DHRHA4	79 L to R	5
E2GQX7	82	5

TABLE 3 - Horizontal (Azimuth)

WebCode	Angle Measurement (degrees)	Uncertainty (degrees)
E7EHEV		
EQHVB	78	5
ERCGQF	40	3
F3QXXD	82	
FEJEME	81	5
G29WD4	79	5
G37897	approx. 10 left to right	N/A
G6ERB9	79	2
G77MXG	8	1
GV3V72	41	1
H3YEUV	76	5
HK3UFV		
HTUYY4	11	5
JNYXKM	82.6	5
K8N774	80.4	2.0
KFKCBJ		
KVAJ7W	8.5	2
LDNHNY	83	5
LE2E86	77	5
LFV3Q2	10	5
LKRQ6M	77	5
LMYEVQ		
LPZCWQ	81	5
LR839T	2	NA
MHYHCW	10	5
NA3AFP	77	5
NBEGUY	~82	N/A
NC83AN		
ND4FWG	10	5
NF97YP	100	
NG6UT2	78	3
NJ9MMZ	78.8	4.4
NYG9YF		
PTEY2	82 degrees left to right	5
PHTM7W	78.5	5

TABLE 3 - Horizontal (Azimuth)

WebCode	Angle Measurement (degrees)	Uncertainty (degrees)
PHVCAT	80	5
Q6VVKV	102	1
R83ZNQ	~80	NA
R9XWKT	101	5
RH32BN	79 from left edge	Not assigned
T28XAB		
T2BKLH		
T397P4	70	5
TRNLVC	82	5
TZEAQE	80	5
UKA9AU	75	5
UPWHQQ	97 degrees	N/A
V8BNPL	80	
VJMJVR	80	5
VML8LR	78	5
X9EYW9	12	5
XLN7MM	8.6	0.5
XQF3YC		
YTKT2K	77.4	5
YV6A8Q	80	5
Z9AK2C		

TABLE 3 - Vertical

WebCode	Angle Measurement (degrees)	Uncertainty (degrees)
2249HK	41	5
2TBVK7	41	5
36XMKZ		
3FXM9K	9.5	
3KCXLN	40	5
3UFFV7	35	2
4396TL	43	5
462AX8		
6JP2VD	42	5
6T2VD2	42	5
74YQYH	41	2
7YJHBH	46.5	0.5
82KBUZ	42	5
8GWGUL	42	
8LQLX4		
8RY8L2	42	5
8YX4KK	43	5
8ZRT4F	42	3
9LNFUE	132	NA
9M2F6B	43	5
ADBRBK	41° frm perpendicular	
AE3CCX	45	5
ATNPRE	40.2	0.4
AXB8UA	43	5
AZ2798	42.6	5
B7MJMZ		
B9PGXT		
BAMRTW	41.8	5
CC6D2A	42	5
D23BDR	130	5
D9HJQA	44	5
DETEVJ	136 Downward	5
DHRHA4	42	5
E2GQX7	40	5
E7EHEV		

TABLE 3 - Vertical

WebCode	Angle Measurement (degrees)	Uncertainty (degrees)
EQHVB	44 +	5
ERCGQF	11	3
F3QXD	41	
FEJEME	44	5
G29WD4	+40	5
G37897	approx. 48 upward	N/A
G6ERB9	40	2
G77MXG	42	1
GV3V72	11	1
H3YEUV	42	5
HK3UFV		
HTUYY4	41	5
JNYXKM	43.4	5
K8N774	40.8	2.0
KFKCBJ		
KVAJ7W	43	2
LDNHNY	47	5
LE2E86	44	5
LFV3Q2	40	5
LKRQ6M	48	5
LMYEVQ		
LPZCWQ	45	5
LR839T	37	NA
MHYHCW	44	5
NA3AFP	42.5	5
NBEGUY	~42	N/A
NC83AN		
ND4FWG	42	5
NF97YP	40	
NG6UT2	41	3
NJ9MMZ	40.3	4.0
NYG9YF		
PETEY2	45 degrees ascending	5
PHTM7W	42.5	5
PHVCAT	40	5

TABLE 3 - Vertical

WebCode	Angle Measurement (degrees)	Uncertainty (degrees)
Q6VVKV	41	1
R83ZNQ	~40	NA
R9XWKT	45	5
RH32BN	+41 (upwards)	not assigned
T28XAB		
T2BKLH		
T397P4	40	5
TRNLVC	42.5	5
TZEAQE	43.5	5
UKA9AU	45	5
UPWHQQ	48 degrees	N/A
V8BNPL	45	
VJMJVR	42	5
VML8LR	+43	5
X9EYW9	42	5
XLN7MM	40.5	0.5
XQF3YC		
YTKT2K	42.6	5
YV6A8Q	40	5
Z9AK2C		

# Conclusions

TABLE 4

WebCode	Conclusions
2249HK	Based on the visual examination and the results obtained from the chemical tests and the trajectory analysis, the two holes in the submitted box are consistent with bullet holes made from a single bullet path. Bullet hole A is consistent with an entrance hole and bullet hole 1 is consistent with an exit hole. The bullet traveled from left to right at a measured angle of $79^{\circ} \pm 5^{\circ}$ , and from front to back with a measured upward angle of $41^{\circ} \pm 5^{\circ}$ .
2TBVK7	The perforating apparent bullet defect (labeled Defect A) had a direction of travel from front to back, left to right, and upward. The entrance defect (A) was elliptical and measured approximately 6mm x 10mm. The exit defect (A1) was elliptical and measured approximately 8mm x 12mm. The azimuth angle of the trajectory associated with Defect A was 81 degrees and the vertical angle was 41 degrees. Trajectory angle measurements are accurate to a +/- 5 degrees.
36XMKZ	Pathway A (including impacts A, 1) is consistent with a bullet traveling from front to back, left to right and in an upward direction.
3FXM9K	On August 20, 2018, I examined a section of a garage wall from a shooting incident sent in to the [laboratory] by. The section of wall was sent in for examination to help determine the angle at which the projectile entered the wall in order to help place the shooter in the scene. The section of wall was approximately 5 $\frac{3}{4}$ inches from left to right and approximately 6 inches from top to bottom. The wall was made of wood boards on either side approximately $\frac{3}{8}$ inch in thickness and had wood beams approximately 2 $\frac{11}{16}$ inches thick in between the wood boards, forming a square, which the outside wood board were attached to by four staples a piece. The section of wall had multiple stickers on it identifying the "Front," "Top," and "Back" of the section of wall. The front section included two stickers with the following information printed on them; sticker #1 "Test No. 18-5620 A," second sticker "Test No. 18-5620 FRONT." The top section had a sticker with the following information printed on it "Test No. 18-5620 TOP." The back section had two stickers with the following information printed on them; sticker #1 "Test No. 18-5620 BACK," second sticker "Test No. 18-5620 1." The front and back sections of the wall had small holes in them. The front side hole was approximately 5 mm in height and 2mm across. The bottom section of this hole had a greyish coloring possibly indicating a bullet wipe. The back side hole was approximately 2mm in height and 3mm across and the wood was splintered around the hole. I utilized a Sodium Rhodizonate test kit to test for the presence of lead on the front hole. The test showed a positive result for the presence of lead. I utilized multiple measurement techniques in order to determine the angle of entry and exit of the projectile through the wall. A.) The first examination I measured the entry hole on the front and rear of the box from the left side of the box and the bottom of the box. I then subtracted the lower section from the entry hole to get a distance from the entry hole to the exit hole up the left hand side of the box (approximately 69.85mm). I measured the thickness of the box (approximately 76.2mm). Using a Tan and INV Tan calculation as listed below I came up with an angle of approximately 42.52 degrees upward. $TAN = 69.85 / 76.2 = .917$ , $INV TAN \text{ of } .917 = 42.52$ . I did the same with the top section of the box using the measurements calculated from the left hand side of the box. The distance between the entry and exit holes was calculated to be approximately 12.7mm and the thickness of the box again was approximately 76.2mm. Using a Tan and INV Tan calculation as listed below I came up with an approximate angle of 9.46 degrees left to right. $TAN = 12.77 / 76.2 = .166$ , $INV TAN .166 = 9.46$ B.) The second examination I constructed a scale diagram using the same left and top sides of the box. I placed marks where the entry and exits holes were measured to then connected them with a straight line. I then created a 90 degree angle using the entry point as a reference mark and placed the line across the side and top of the scale diagrams accordingly. Using a protractor I was able to approximate the angles as follows: Entry to exit from front to back 42.5 degrees upward, and entry to exit front to back 9.5 degrees from left to right. C.) The third method I used to obtain approximate measurements was by placing a metal rod through the entry hole and exiting the exit hole. In order to center the rod in each hole I placed tape around the rod where it entered and exited so it would not wiggle within each hole. I then used a protractor (without bottom edge ruler) and was able to approximate the measurements as 46 degrees upwards and 6 degrees left to right. This method had many factors that could have altered the results such as the rod may have been bent inside the wall due to angles, the rod may not have been exactly centered in the holes, and the ability to find the exact

TABLE 4

WebCode	Conclusions
	center of the rod with tape on it when placing the protractor up against the rod.
3KCXLN	The bullet impact site was on the A side of the block of wood; the bullet traveled left to right from front to back in an upward angle. The horizontal angle measurement was $80^{\circ} \pm 5^{\circ}$ and the vertical measurement was $40^{\circ} \pm 5^{\circ}$ .
3UFFV7	The bullet trajectory went into the front wall going upward 35 degree (vertical angle), left side to right side 77 degree (Horizontal angle) and the bullet exit from the back wall.
4396TL	A single projectile perforated the box, entering through Side A and exiting through Side 1. The projectile traveled upward at approximately 43 degrees and 10 degrees from left to right.
462AX8	Pathway A (including impacts A, 1) is consistent with a bullet traveling from front to back, left to right and in an upward direction.
6JP2VD	A bullet path with a perforating bullet defects was on the wood block with an entry defect on the side labeled 'A' and an exit defect on the side labeled '1'. The path of this trajectory is from front to back at an upward angle of 42 degrees and from left to right at an angle of 79 degrees. Disclaimer: Trajectory angle measurements are accurate to a plus/minus 5 degrees.
6T2VD2	Approximate trajectory measurements were recorded.
74YQYH	Direction of a shot is from front to back, upwards, 41 degrees +/- 2 degrees vertical, shot from left to right horizontal angle 7 degrees +/- 2 degrees. Probably caliber .22
7YJHBH	Entrance hole A and Exit hole 1 are consistent with being caused by one (1) projectile. This projectile was fired upward at a vertical angle of $46.5^{\circ} \pm 0.5^{\circ}$ above the horizontal plane and at an azimuth angle of $79.5^{\circ} \pm 0.5^{\circ}$ along the horizontal plane anticlockwise from the front left hand side of the section of partition wall. This projectile appears to have entered the lower front of the partition wall, travelled through and exited through the upper back of the partition wall.
82KBUZ	Defect A is a perforating entrance bullet defect located on the front wall, 67mm from the left side of the partition and 38mm up from the bottom of the partition. Defect 1 is a perforating exit bullet defect located on the back wall, 80mm from the left side of the partition and 105mm up from the bottom of the partition. The trajectory for the bullet passing through the partition (defects A and 1) was front to back, impacting the wall at 82 degrees from left to right and upward at a vertical angle of 42 degrees. Trajectory angle measurements are accurate to a plus/minus 5 degrees.
8GWGUL	The fired bullet penetrated the front of the partition wall "A". Defect "A" Interior measurements - Length approximately .7mm, Width approximately .5mm. Defect "1" Interior measurements - Length approximately .7mm, Width approximately .5mm. The horizontal impact angle along the path of the fired bullet was approximately 83 degrees from left to right when facing the partition wall. The vertical impact angle along the path of the fired bullet was approximately 42 degrees upward when facing the partition wall. The fired bullet exited the back side "1" of the partition wall.
8LQLX4	Pathway A (including impacts A, 1) is consistent with a bullet traveling from front to back, left to right and in an upward direction.
8RY8L2	Item 1 was examined and found to be a partition wall with labels indicating the orientation. One side was labeled "A" and "FRONT" and the other side labeled "1" and "BACK". The top was labeled as "TOP". The side labeled "A" and "FRONT" had a defect close to the bottom and the side labeled "1" and "BACK" had a defect in the middle close to the top. It was determined that the defect on the side labeled "A" and "FRONT" was the entrance hole due to the presence of a lead-in mark at the bottom edge of the defect and the wood fibers being forced into the defect. No powder particles were observed on the entrance side indicating that the shot was either fired from a distance or has gone through an intermediary object shielding the wall partition from the powder particles. By using a trajectory rod, plumb bob line, zero edge protractor and inclinometer, the path of the bullet through the wall partition was determined as entering from the side labeled "A", travelling from front to back, left to right at an upwards angle and exiting on the side labeled "1". The azimuth angle was measured from left to right facing side "A" as approximately $79^{\circ} \pm 5^{\circ}$ degrees. The vertical angle was measured as approximately $+42^{\circ}$ degrees (upwards) $\pm 5^{\circ}$ degrees.



TABLE 4

WebCode	Conclusions
8YX4KK	INTERPRETATIONS & OPINIONS: Item 1 – The entrance hole is located on the side designated “Front” due to the wood splinters being pushed in. The exit hole is on the side designated “Back” due to the wood being pushed out. The horizontal angle is 11 degrees from left to right, when facing the wall. The vertical angle is 43 degrees upward.
8ZRT4F	The present defect, caused by a firearm, in the wooden wall of the garage was shot from front to back, from bottom-up from left to right. The azimuth angle represent about 9+/-3 degrees whereas the elevation angle represent about 42+/-3 degrees. The reference plane, with which the elevation value was measured, is perpendicular to the surface of the wall and parallel to the bottom of the box. The reference plane used to measure the azimuth is a plane parallel to the left side of the wooden box.
9LNFUE	Lead: Examination and chemical testing of the following indicated the presence of lead, consistent with the passage or impact of a bullet: Defect A, entrance Trajectory: Analysis of the hole on the lower front of the wall partition indicated that a projectile was moving from left to right at an upward angle when it perforated the wall.
9M2F6B	A perforating hole was found in the section of the submitted partition wall. A lead in mark on the entry side and the fractured, blown-out appearance on the exit side was observed, consistent with a bullet path. The hole was probed, and the angles of the bullet path measured. The bullet entered the wall on side “A” traveling upward at approximately 43 degrees and left to right at approximately 81 degrees to the wall on the left side of the entry hole. The bullet exited on the wall on side “1”.
ADRBK	The wall section submitted has a single defect in the front marked "A" (front) and a single defect in the back marked "1" (back). The defect in wall "A" was labeled as Defect "A" and the defect in wall "1" was labeled as Defect "A1". Defect "A" has the appearances of an entry and Defect "A1" has the appearances of an exit. A trajectory rod was inserted into Defect "A" and exited Defect "A1". Utilizing a zero-edge protractor, levels, and a plumb bob, the elevation and azimuth angles were collected as follows; Defect "A" elevation (vertical angle) - approximately 41° from perpendicular, Defect "A1" azimuth (horizontal angle) - approximately 9° from perpendicular. The fired bullet entered wall "A" moving at an upward angle and moving from left to right.
AE3CCX	The defect located on the front side of box was caused by a bullet travelling from front side of box towards backside at horizontal angle of approximately 77 degrees ± 5 from right to left of the box and in upward direction at a vertical angle of approximately 45 degrees ± 5.
ATNPRE	The box recive a single shot, the bullet entered through the entrance hole labeled "FRONT" "A" identified OE1, exiting through the exit hole labeled "BACK" "1" identified OS1. The trajectory is from front to back, from bottom to top and slightly from left to right.
AXB8UA	A bullet entered the front of the wooden block, labeled as "Test No. 18-5620 A", and exited the back of the block, labeled as "Test No. 18-5620 1". The trajectory associated with the bullet defects on the wooden block was upward and slightly left to right.
AZ2798	An examination was conducted of the defect in the submitted section of wall and it found that there was a perforation through the wall. The projectile has travelled from the side marked 'Front' and 'A' and exited the side marked 'Rear' and '1'. A trajectory rod was placed through this perforation which indicated an upward and left to right trajectory when viewed from the 'Front' side of the wall.
B7MJMZ	Pathway A (including impacts A, 1) is consistent with a bullet traveling from front to back, left to right, and in an upward direction.
B9PGXT	Pathway A (including impacts A, 1) is consistent with a bullet traveling from front to back, left to right, and in an upward direction.
BAMRTW	Bullet defect A was a perforating bullet defect located towards the bottom edge of the wooden box on the side labeled 'A'. The trajectory associated with bullet defect A was left to right at an azimuth angle of 79 degrees, front to back, and upwards at an angle of 41.8 degrees.
CC6D2A	A trajectory analysis was performed on the submitted section of partition wall. Bullet path A - This bullet perforated the partition wall entering at Defect A and exiting at Defect 1. The bullet path has an azimuth

TABLE 4

WebCode	Conclusions
	angle of 100 degrees (measured right to left when facing wall) and a vertical angle of 42 degrees.
D23BDR	Shooting direction is upward, from left to right. Horizontal entrance angle is 77 degrees and vertical entrance angle is 130 degrees when zero angles are on the left and up. Uncertainty angles are 5 degrees for all directions.
D9HJQA	Wall "A" was examined and the circular defect was determined to be the entry impact point. The direction of travel was left to right, front to back at a upward angle. The horizontal acute angle measured 81 degrees left to right with 2 degrees plus or minus of uncertainty. The vertical acute angle measured 44 degrees upward with 5 degrees plus or minus of uncertainty.
DETEVJ	One semi-circular, perforating entrance defect with a regular margin in the side labeled "front" of the wood box. A marginal abrasion is visible around the periphery of the lower half of the defect. Material fragments are pushed inward at the bottom edge of the hole. The defect measures approximately 5mm x 8mm. On the opposite/"back" side of the box is a semi-circular, perforating exit defect with a rough margin in the interior surface; additionally, the defect's margin on the outer surface is irregular in shape with material fragments pushed outward from the defect. The defect at the outer surface measures approximately 24mm x 13mm. Trajectory is front to back, left to right and upward: Horizontal angle 80 degrees left to right +/- 5 degrees; vertical angle 136 downward +/- 5 degrees.
DHRHA4	Based on the location and features of the two perforations, it was established that the trajectory was consistent with the passage of a bullet from front (face marked "Test No. 18-5620 A") to back (face marked "Test No. 18-5620 1"), from left to right and with an upwards angle. Based on the measurements of the entry hole, the vertical angle was estimated to be approximately +40 degrees. Based on the relative measurements of the position of the perforations, the horizontal angle was estimated to be approximately 79 degrees left to right. A trajectory rod was placed through the perforations and the horizontal and vertical angles were measured using a protractor and plumb line. The vertical angle was established to be approximately +42 degrees and the horizontal angle was approximately 79 degrees left to right. Angles were confirmed with photographic methods and inclinometer.
E2GQX7	The "Front" surface of the partition wall was found to have an entry hole measuring approximately 9 millimetres (mm) by 6 mm, located at approximately 64 mm from the left side of the "Front" surface, at a height of approximately 26 mm. The "Back" surface of the partition wall was found to have an exit hole measuring approximately 11 mm by 11 mm, located at approximately 71 mm from the right side of the "Front" surface, at a height of approximately 103 mm. The trajectory was determined to be 82 degrees (+- 5 degrees) from left to right (when viewed facing the "Front" surface) and 40 degrees (+- 5 degrees) upwards.
E7EHEV	Pathway A (including impacts A, 1) is consistent with a bullet traveling from front to back, left to right, and in an upward direction.
EQHVYB	The following apparent impact was determined: A: A perforating hole near the bottom center of the side labelled "front" approximately 1 5/8" up from the bottom of the box and approximately 2 3/4" to the right of the left side of the box. The hole was slightly oblique with material pushed inward and lead wipe (apparent) exhibited on the bottom portion of the hole. The directionality is front to back, left to right at approximately 78° and approximately 40° upward. A1: An apparent exit hole on the "back" (labeled) side of the box. Material was removed from the exterior of the plywood and pushed outward. The hole was located approximately 3 5/16" to the right from the left side of the box and approximately 4 1/4" up from the bottom of the box.
ERCGQF	The causative bullet had entered the front of the partition wall, tracked through it and exited from the back. The bullet's trajectory was upwards (at an approximate angle of 40 degrees from the horizontal) and left to right (at an approximate angle of 10 degrees from the vertical) as looking towards the front of the wall.
F3QXXD	A pink trajectory rod was inserted into Defect "A", exiting through Defect "1". The vertical and horizontal angles of the pink trajectory rod were obtained utilizing an angle indicator for the vertical angle and a zero-edge protractor for the horizontal angle as follows: Defect "A" horizontal angle – the bullet entered the wall moving from left to right at approximately 82° from parallel. Defect "A" vertical angle – the bullet

TABLE 4

WebCode	Conclusions
	entered the wall moving at an upward angle of approximately 41° from parallel.
FEJEME	I observed a perforating impact, consistent with an entrance, bullet hole, in the partition wall on the side labeled "A-Front". The impact appeared to have blackening around the hole, consistent with bullet wipe. The perforating impact appeared to originate in the entrance side labeled "A-Front" and continue (perforate) to the exit side labeled "1-Back". The entrance impact on the partition wall was located approximately 2.2 cm from the bottom of the partition wall and 6.4 cm from the left side of the partition wall (as one looks at the partition wall from the side labeled "A-Front". I placed a metal rod into the entrance impact ("A-Front") and the rod effortlessly continued to the exit ("1-Back") impact. With the metal rod in place, the entrance impact ("A-Front") originated from approximately 81° (from left to right, with a 5° uncertainty) and upward at 44° (with a 5° uncertainty).
G29WD4	Trajectory measurements were made, and documented with notes and photographs.
G37897	A section of partition wall was submitted for possible trajectory analysis. Three sides of the section of wall were previously marked FRONT (A), BACK (1) and TOP for orientation purposes. There was a hole in the surface of the side marked FRONT (A) and a second hole in the surface of the side marked BACK (1). Examination and chemical testing of the holes indicated the presence of lead, consistent with the passage of a bullet. Trajectory analysis indicated the shot originated from the FRONT (A) and perforated the wall, traveling slightly left to right with an upward angle, and exited out the BACK (B) of the wall.
G6ERB9	The damage to the section of the partition wall was caused by a single projectile that was travelling from the left to the right with an azimuth angle of approximately 79 degrees +/- 2 degrees, from the front to the back and upward at an angle of approximately 40 degrees +/- 2 degrees.
G77MXG	After examining the box and using conveyor angles and ballistic rod, the following results have been defined: There is a unique entrance hole (side A) and an exit hole (side 1), both connected and produced by the same firearm bullet. The trajectory angles are as following: Upward slant regarding the horizontal plane 42° (+/-1°) Drift left to right (lateral deviation) with respect to the sagittal plane 8° (+/-1°).
GV3V72	The entrance hole is in the box's front (A) side. The shot's direction is from down to up (upward), from left to right at a 41°±1° vertical and 11°±1° horizontal angle.
H3YEUV	Macroscopic and microscopic examination of Exhibit 1(18-5620) determined that Side A contains a perforated hole on the bottom left side of the panel. This hole has physical characteristics consistent with an entrance hole, produced by the passage of a bullet and corresponds with an exit hole on Side 1. By inserting a trajectory rod/probe through the both the entrance and exit holes, Exhibit 1(18-5620) was determined to have a front to back trajectory with the following direct angle measurements noted below: x axis (azimuth/horizontal) = approximately 76 degrees, left to right y axis (vertical) = approximately 42 degrees, upward
HK3UFV	Pathway A (including impacts A, 1) is consistent with a bullet traveling from front to back, left to right, and in an upward direction.
HTUY4	Initial Analysis: The defects appeared to be consistent with being caused by a single projectile with the entrance being on the side with the front label and the exit on the side with the back label. Trajectory Examination: A trajectory rod was inserted into the defect on the entrance side and through the defect on the exit side. A protractor was placed underneath the defect on the entrance side. With perpendicular or 90 degrees being used as the zero point, it showed that the azimuth or horizontal angle to be approximately 11 degrees from the left direction to the right. A protractor was placed behind the trajectory rod at the defect location to determine the elevation or vertical angle. With perpendicular or 90 degrees being used as the zero point, it showed the angle to be approximately 41 degrees in an upward direction. A digital angle gauge was also placed on the trajectory rod and showed it to be 41.5 degrees. Conclusion: The trajectory of the projectile was in an upward angle ~41 degrees from left to right ~11 degrees (+/- 5 degrees).
JNYXKM	A small hole, visually consistent with a perforating entrance bullet defect was located along the lower middle face of the side of the box labeled "FRONT". This defect measured 6mm by 7mm and was slightly elliptical in shape. An irregular-shaped hole, visually consistent with a perforating exit bullet defect was located near the upper middle portion of the side of the box labeled "BACK". This defect measured

TABLE 4

WebCode	Conclusions
	1.5cm by 1.5cm in size. A trajectory rod was fit between the defects on the FRONT and BACK sides of the block. The elevation angle of this trajectory was measured at 43.4 degrees upward and the azimuth angle was measured at 82.6 degrees with a left to right direction of bullet travel, relative to the front of the box.
K8N774	The box (a section of a partition wall from a garage) received a single shot, the bullet entered through the entrance hole labeled A and exited through the exit hole labeled 1. A trajectory that associates both holes was determined, which locating a person in front of the box can be described with the following address: enter through the front of the box towards the back of the box, from bottom to top (upward) with a vertical angle of $40.8^{\circ} \pm 2.0^{\circ}$ , from left to right with a horizontal angle of $80.4^{\circ} \pm 2.0^{\circ}$ .
KFKCBJ	Pathway A (including impacts A, 1) is consistent with a bullet traveling from front to back, left to right, and in an upward direction.
KVAJ7W	The projectile has entered the wall (surface A) in a rising trajectory (through and out surface 1), measured and calculated to approximately 43 degrees (+-2 degrees) and from left to right at approximately 8,5 degrees (+-2 degrees).
LDNHNY	Arrived on scene at 1330. Documented trajectory data using notes, photography, measurements and diagrams. All aspects of the scene processing were performed by [name]. Secured from scene and returned to the lab at 1530.
LE2E86	A trajectory analysis was performed on Item 1 and the following opinions were determined: A bullet struck the front wall approximately 1 7/16 inches above the floor and 2 5/8 inches from the left side of the wall at Hole A and traveled through the wall exiting the back of the wall at Hole 1. The vertical component of the bullet's path through the wall was approximately 44 degrees upward, and the azimuth component was approximately 77 degrees with a left-to-right track. The interpretations and opinions in this document are based upon my knowledge of the case factors available to me the time this report was authored.
LFV3Q2	On Tuesday, 07/31/18 I received a sealed cardboard box via evidence technician at [laboratory]. On 08/01/18 at approximately 1002 hours, I broke the seal on the cardboard box and removed a constructed block of wood labeled as test number 18-5620. This box contained two (2) defects, one located on side A and one on side 1. A defect was noted on side A located approximately 30mm upward from the bottom of the wooden box, approximately 68mm from the left side and approximately 83mm from the right side. All measurements are assuming looking directly at side A. This defect was approximately 3mm in width and 5mm in length. the defect had smooth margins and had what appeared to be a gray/black wipe at the bottom margin. A defect was also noted on the back or side 1 located approximately 95mm upward from the bottom, approximately 67mm from the left side and approximately 85mm from the right side again assuming looking directly at side 1. This defect measured approximately 6mm in width and approximate 11 mm in length. The margins of this defect were ragged and uneven. The direction of the path of the trajectory was from front to back, upward and left to right. The defect on side A was photographed with and without scale and was labeled as "defect 1" for identification purposes. The defect on side 1 was labeled as "defect 2" also for identification purposes. A trajectory rod was inserted into the defect on side A, defect 1, through the interior of the box and was allowed to exit on side 1 through defect 2. It was noted that the trajectory was a steep upward angle of approximately 40 degrees as measured both by an electronic angle finder and a manual angle finder. Utilizing a zero edge protractor, the trajectory was found to be from left to right at approximately a 10 degree angle. All angles were photographed with the trajectory rod in place.
LKRQ6M	A small wooden box was received for examination. The box was photographed and measured. The box contained defects that appeared to be consistent with the passing of a projectile. The defects were observed on the front and back sides of the box. The defect on the front of the box (entrance hole) was labeled "A" and the defect on the back (exit hole) was labeled "1." The projectile path was left to right, front to back, and upward. The vertical angle was 48 degrees (+/- 5 degrees). The horizontal angle was 77 degrees (+/- 5 degrees). It should be noted that the measurement uncertainty of +/- 5 degrees is generally accepted in shooting reconstruction. Additional measurements are available upon request.
LMYEVQ	Pathway A (including impacts A,1) is consistent with a bullet traveling from left to right, front to back and

TABLE 4

WebCode	Conclusions
	in an upward direction.
LPZCWQ	The bullet appeared to be traveling from the front to the back of the wall at an upward angle and from left to right.
LR839T	Results: Note: The inclination angle is reported relative to the item when placed on level ground. The azimuth angle is defined with 0 degrees as perpendicular to the surface struck. There was a defect on the section of a partition wall from a garage (item 1). The projectile associated with this defect struck the front, at an upward angle of 37 degrees and an angle of 2 degrees from the left to the right. It then exited out the back of item 1.
MHYHCW	The bullet progressed on an axis oriented: from front to back, from bottom to top with an angle of about 44 degrees (+/- 5 degrees) to the horizontal plane, from right to left with an angle of about 10 degrees (+/- 5 degrees) to the longitudinal plane.
NA3AFP	Macrosopic examination determined that Exhibit 18-5620 contains a perforated hole that is consistent with having been produced by the passage of a bullet. This bullet struck Exhibit 18-5620 traveling from front to rear based on the physical damage. Additionally, it was calculated using the physical projection method that the bullet impacted Exhibit 18-5620 at an upward (vertical) angle of approximately 42.5° from the level plane traversing the entrance hole, and at a lateral (horizontal) angle of approximately 77° from left to right when facing the front wall.
NBEGUY	Examination of the section of wall revealed the presence of physical damage consistent with a bullet perforating the wall, with the bullet entrance on the side marked with an "A", (The front side), occurring at approximately 2 11/16 inches from the left side and approximately 1 7/16 inches from the bottom. The bullet causing this damage traveled front to back, upward, and slightly left to right. The trajectory was determined to have an approximately 42 degree incline, and the horizontal angle was determined to be approximately 8 degrees, left of center. The position and angular measurements reported relative to the trajectory are offered for descriptive purposes.
NC83AN	Pathway A (including impacts A, 1) is consistent with a bullet traveling from front to back, left to right and in an upward direction.
ND4FWG	Hole A is one oblong entrance bullet hole measuring 1/8" wide by 3/16" tall. It is located in the lower left of center area on the front side of the wall: 2 3/4" right of the front left side of the wall and 4 3/8" down from the top of the wall. Hole 1 is one oblong exit bullet hole measuring 3/16" wide by 1/4" tall. It is located in the upper left of center area on the back side of the wall: 2 3/4" right of the back left side of the wall and 2 1/2" down from the top of the wall. The fired bullet traveled from left to right, from the front of the wall to the back of the wall at an upward angle of 42 degrees (+/- 5 degrees) and a horizontal angle of 10 degrees (+/- 5 degrees) left of perpendicular to the front side of the wall.
NF97YP	The missile traveled in a left to right direction, perforating the front (A) of the wall at an upward angle of 40 degrees and approximately 100 degrees right left, exiting the back (1) of the wall.
NG6UT2	The shot was fired in a direction from front to back, left to right and upwards. The vertical angle of the bullet's path though the box was approximately 41 degrees upwards (+/- 3 degrees). The azimuth angle of the bullet's path through the box was approximately 78 degrees (+/- 3 degrees)
NJ9MMZ	The wall was hit by a bullet traveling through it with a 40.3° upward angle and a 78.8° left to right track angle according to a person facing the wall. The bullet struck the front side and got to exit the back side of the wall.
NYG9YF	Pathway A (including impacts A, 1) is consistent with a bullet traveling from front to back, left to right and in an upward direction.
PETAY2	The projectile penetrated through the front side of the wooden block and exited the back side. The R/O ascertained that the approximate trajectory for the projectile was 82° left to right and 45° ascending.
PHTM7W	Front to back (A to 1) 42.5 +/- 5 degrees upward 78.5 +/- 5 degrees left to right
PHVCAT	The hole on the side of the box labeled "Front" has bullet wipe and a lead in mark, which indicate that it is the entrance hole. The hole on the side of the box labeled "Back" has splintering of the wood fibers,

TABLE 4

WebCode	Conclusions
	which indicate that it is an exit hole. The vertical angle is 40 degrees upward +/- 5 degrees, and the azimuth angle is 80 degrees +/- 5 degrees. Based on measurements and visual observations, the direction of travel is left to right, front to back, and upward.
Q6VVKV	Exhibit AD is a section of wall constructed of plywood bearing a hole on both wall surfaces. The hole in the wall surface marked "FRONT" is physically consistent with a bullet having entered this side. The hole in the wall surface marked "BACK" is physically consistent with a bullet having exited this side. The two holes are physically consistent with a single bullet path. The vertical impact angle is 41 degrees +/- 1 degree (upward trajectory) and the azimuth impact angle is 102 degrees +/- 1 degree (left to right trajectory).
R83ZNQ	The bullet entered the front side of the box, travelled slightly right in an upwards angle, and exited the back side of the box.
R9XWKT	The wooden box was examined to determine the path the projectile traveled. It was determined that the projectile traveled from the front side of the box (hole A) to the back (hole 1). The projectile traveled in an upward direction at 45 (+/- 5) degrees. The projectile traveled from left to right at 101 (+/- 5) degrees.
RH32BN	With regards to the above listed wall (Item 001), I performed the following actions: Made notes related to my observations. Performed trace metal tests for lead. The results of chemical tests for lead were packaged separately and retained with Item 001. Took measurements of possible projectile strike mark locations. Determined, where possible, the projectile trajectories associated with the shooting incident. Took photos related to the documentation of projectile trajectories. Additional documentation is available in the case record and can be provided upon request. As requested by the CTS form: The partition wall was marked "Front", "Back", and "Top". The hole located on the front of the wall was additionally marked "A" and the hole located on the back of the wall was marked "1". 1.) Which label on the box represents the entrance? A 2.) What is the direction of travel of the bullet through the box? Left to right, front to back, and upward. 3.) Please record your angles below. Horizontal (Azimuth): 79 degrees from the left edge / No uncertainty is assigned. Vertical: +41 degrees (upward) / No uncertainty is assigned.
T28XAB	Pathway A (including impacts A, 1) is consistent with a bullet traveling from front to back, left to right and in an upward direction.
T2BKLH	Pathway A (including impacts A, 1) is consistent with a bullet traveling from left to right, front to back, and in an upward direction.
T397P4	A bullet defect was located on the target approximately ~6.8 cm from the left edge and ~2.5 cm from the bottom edge. The size of the defect was ~6mm x ~9.5mm. The bullet's path of travel was determined* to be from left to right at ~70 degrees off the left side of the wall and at an upward angle of ~40 degree.
TRNLVC	The defect present in the Front side of the wooden block (defect marked 1A), was made by a fired projectile. Trajectory measurements indicated that the bullet passed through the block at a 42.5 degree upward angle and 82 degree angle from left to right.
TZEAQE	There is a bullet hole entrance to the front of wood panel A, exiting the back of the partition wall (Side 1). A bullet wipe is visible at the bottom of the hole on side A. The bullet perforated the surfaces from front to back (Side A to Side 1). The vertical component of the bullet path was approximately 43.5 degrees upward and the azimuth component was 80 degrees out of the plane of the wall with a left to right track as you face the wall. The top of the hole is approximately 4 inches from the top of the wall section. The right edge of the hole is approximately 3 3/8" from the right edge of the wall section. The hole is approximately 1/4" in diameter.
UKA9AU	I observed a perforating impact to a wooden wall. The possible projectile path was from front to back with a left to right trajectory and upward. The upward angle was approximately 45° and the azimuth angle was approximately 75°.
UPWHQQ	The perforating defect appeared to have entered side "A" left to right at a 97 degree angle while traveling in an upward 48 degree angle before exiting side 1.
V8BNPL	Defect A is present on the lower front side of the Item 1 wall and was caused by a projectile traveling



TABLE 4

WebCode	Conclusions
	from front to back, left to right and upwards.
VJMJVR	The front side of the wall has a perforation hole which is consistent with the passage of a projectile entering the wall. The hole is identified as "hole A". The back side of the wall has a corresponding hole, identified as "hole 1", and is consistent with an exit hole. The direction of travel is from front to back with an upward angle of approximately 42°, and a left to right angle of approximately 80°.
VML8LR	One (1) bullet defect was located on the "A" side of the wall. A corresponding exit was located on the "1" side of the wall. The directionality was noted to be front to back, left to right and upward. Trajectory Determination was performed on the suitable defect area, which included determination of both the horizontal and vertical angle of incidence. The results of analysis is: Vertical Angle = +43°, Horizontal Angle = 78°.
X9EYW9	Marker (A) indicates an apparent bullet entry defect on the FRONT surface of the garage partition wall. Marker (1) indicates an apparent bullet exit defect on the BACK surface of the garage partition wall. Taken together, defects (A) and (1) indicate an apparent bullet perforation of the garage partition wall. The apparent bullet path is from FRONT to BACK, upward, and from left to right (when facing the FRONT surface).
XLN7MM	The box has a defect on the "A" side and a defect on "1" side. The defect on the "A" side is oval and has a width of about 5 mm and a length of about 7.6 mm. It looks like an entry hole, caused by a bullet .22 caliber. The wet-chemical test for lead abrasion at the entry bullet hole ("A" side) was positive. The defect on the "1" side looks like an exit bullet hole. Through both bullet holes, a trajectory rod was inserted. The trajectory runs ascending from left to right and from the front to the back. The horizontal entry angle (azimuth) is approximately 8.6° (± 0.5°). The vertical entry angle is approximately 40.5° (± 0.5°).
XQF3YC	Pathway A (including impacts A, 1) is consistent with a bullet traveling from left to right, front to back and in an upward direction.
YTKT2K	A single perforating bullet defect was in the submitted block of wood reported to be a portion of a wall. The defect was mostly circular in shape with a blackish-gray deposit on the bottom area of the defect. The wood was pushed inwards on the bottom and sides of the defect. The trajectory associated with this bullet defect was front to back with a slight left to right horizontal angle of 77.4 degrees (counterclockwise from the front of the block) and an upwards elevation angle of 42.6 degrees.
YV6A8Q	The projectile perforated the front wooden panel (side labeled A) of the box, perforated the back wooden panel (side labeled 1) of the box, and then continued in an unknown direction. The projectile path was 40 degrees ascending and 80 degrees left to right.
Z9AK2C	Pathway A (including impacts A, 1) is consistent with a bullet traveling from front to back, left to right and in a upward direction.

## Additional Comments

TABLE 5

WebCode	Additional Comments
3FXM9K	In relation to question #3 and uncertainty of measurement, this lab performs no critical quantitative examinations. Angle approximations as shown above are furnished for investigative purposes.
3KCXLN	None of our trajectory rods would fit through the bullet holes in the block of wood. We had to substitute a small straight rod through the holes to get a measurement.
7YJHBH	I tested entrance hole A and exit hole 1 for the presence of copper and lead. I detected the presence of both copper and lead on entrance hole A. I detected the presence of lead only on exit hole 1. This is consistent with these holes having been struck by a metal jacketed plated bullet with a lead core.
8YX4KK	The horizontal angle was calculated from 90 degrees.
9LNFUE	Angles based on: Horizontal; 0 degrees at left (on the wall), measuring left to right. Vertical; based on plumb bob, with 0 degrees at the top measuring downward to rod. We do not give an uncertainty measurement
ADRBK	Defect "A" and corresponding Defect "A1" are a perforating defect passing thru the wall section. The internal measurements of Defect "A" were collected utilizing a caliper and are as follows; Defect "A" length - approximately 7mm. Defect "A" width - approximately 6mm. The edges of Defect "A" were smooth along the bottom, left, and right sides of the defect and rough near the top of the defect. Bullet wipe was observed along the bottom edge of the defect. Defect "A" had the appearance of an entry defect as material along the edges of the defect appeared to be pushed inward and was oval in shape. Presumptive tests for copper and lead were performed on Defect "A" with a positive test for copper and a positive test for lead. Defect "A1" had the appearance of an exit as the defect appeared larger than Defect "A" with a nondescript shape and irregular edges and material around the edges was pushed outward.
AE3CCX	Lead in mark was observed on front side of the box indicating entry hole of the bullet on front side of the box and was mentioned as 'A', while exit hole on backside of the box was mentioned as '1'.
B9PGXT	Observations: The above listed item was visually examined for the presence of possible impacts. Impact A - Perforating impact, located on the front surface of the wall. Impact 1 - Perforating impact, located on the back surface of the wall.
DETEVJ	Angles were determined using a trajectory rod centered through the corresponding entrance and exit defects. An angle finder was utilized to determine the vertical angle and a 180 degree protractor and plumb-bob was used to determine the horizontal angle.
DHRHA4	It was noted that the construction of the box resulted in the base of the box not being level.
FEJEME	As a suggestion, in the future, CTS should use holes that "normal" trajectory rods can fit in. We have two shooting reconstruction kits, and none of the standard rods fed into the hole.
G29WD4	Probable path of the bullet was from left to right, as one faces the front of the wall piece, with an upward trajectory. Horizontal angle from the left side of the wall is approximately 79 degrees. Vertical angle from the horizontal plane (90 degrees to the wall face) is approximately 40 degrees.
G37897	Per our agency methods and SOPs, specific measurements of locations and/or angles are not normally included in field reports. For this test, Azimuth Angle measured from orthogonal. Vertical angle measured from 0 degree straight downward.



TABLE 5

WebCode	Additional Comments
GV3V72	Because of the diameter of the entrance hole the bullet probably was 4,5 mm (0.177").
LDNHNY	The Horizontal angle component of the bullet trajectory was measured from the horizontal plane of the wall to the trajectory rod. The vertical component of the bullet trajectory was measured from a plane parallel to the bottom of the wall section and orthogonal to the plane of the wall.
LE2E86	Used the acute angle for horizontal measurement
NBEGUY	The attached report [Table#-?: Conclusions] reflects this laboratory's policy of using an orthogonal impact as zero, zero. The horizontal angle was reported on CTS data sheet based on majority of reporting from last summary report.
R83ZNQ	Measurements are an approximation.
T397P4	*The angles were determined by used of a rod through the defect, a protractor, a digital angle finder, and calculation of the width & length of entrance defect. The uncertainty was +/- 5 degrees.
VML8LR	Uncertainty of Measurement: As shown in this report, trajectory angles are within the $\pm 5^\circ$ uncertainty of measurement. The coverage probabilities for the reported angles are approximately 99%; meaning the reported range will include the true value 99% of the time.
X9EYW9	Reference for the reported angles: Horizontal Angle: Zero being referenced as perpendicular to the (FRONT or BACK) surface of the partition wall. Vertical Angle: Zero being referenced as parallel to the horizontal plane. Uncertainty in angles: $\pm 5^\circ$ , not based on empirical data.

-End of Report-  
(Appendix may follow)

## Appendix: Data Sheet

Collaborative Testing Services ~ Forensic Testing Program

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### Test No. 18-5620: Shooting Reconstruction: Angle Determination

DATA MUST BE RECEIVED BY October 08, 2018 TO BE INCLUDED IN THE REPORT

Participant Code:

WebCode:

#### Accreditation Release Statement

CTS submits external proficiency test data directly to ASCLD/LAB, ANAB, and A2LA. Please select one of the following statements to ensure your data is handled appropriately.

- ☐ This participant's data is intended for submission to ASCLD/LAB, ANAB, and/or A2LA.  
(Accreditation Release section on the last page must be completed and submitted.)
- ☐ This participant's data is **NOT** intended for submission to ASCLD/LAB, ANAB, and/or A2LA.

#### Scenario:

Investigators have submitted a section of a partition wall from a garage in which a shooting took place. They are asking you to conduct your analysis using your laboratory's procedures.

Please note:

- For this exercise, the sample contains a "FRONT", "BACK" and "TOP" label for orientation purposes.
- The sample has been labeled with two different characters ("A" and "1") in which participants can use as reference in reporting.
- Make sure to place the sample on a flat surface when measuring angles.

#### Item Submitted (Sample Pack AD):

- A section of the partition wall which contains one entrance hole and one exit hole.

#### 1.) Which label on the box represents the entrance hole?

☐ A      ☐ 1

#### 2.) What is the direction of travel of the bullet through the box? (Select one from each column)

<input type="checkbox"/> Left to Right	<input type="checkbox"/> Front to Back	<input type="checkbox"/> Upward
<input type="checkbox"/> Right to Left	<input type="checkbox"/> Back to Front	<input type="checkbox"/> Downward

#### 3.) Please record your angles below. (The angles provided below may differ from your normal terminology. You may use your preferred terminology in the conclusions section of the data sheet.)

	Angle Measurement (in degrees)		Uncertainty (in degrees)
Horizontal (Azimuth)	_____	±	_____
Vertical	_____	±	_____

**Please return all pages of this data sheet.**

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[illegible]

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MAIL: Collaborative Testing Services, Inc.  
P.O. Box 650820  
Sterling, VA 20165-0820 USA

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## Collaborative Testing Services ~ Forensic Testing Program

**RELEASE OF DATA TO ACCREDITATION BODIES**

The following Accreditation Releases will apply only to:

Participant Code:

WebCode:

for Test No. **18-5620: Shooting Reconstruction: Angle Determination**

This release page must be completed and received by **October 8, 2018** to have this participant's submitted data included in the reports forwarded to the respective Accreditation Bodies.

Have the laboratory's designated individual complete the following steps  
**only if your laboratory is accredited in this testing/calibration discipline**  
by one or more of the following Accreditation Bodies.

**Step 1: Provide the applicable Accreditation Certificate Number(s) for your laboratory**

**ANAB** Certificate No. \_\_\_\_\_  
(Include ASCLD/LAB Certificate here)

**A2LA** Certificate No. \_\_\_\_\_

**Step 2: Complete the Laboratory Identifying Information in its entirety**

Signature and Title \_\_\_\_\_

Laboratory Name \_\_\_\_\_

Location (City/State) \_\_\_\_\_

**Accreditation Release****Return Instructions**

*Please submit the completed Accreditation Release at the same time as your full data sheet. See Data Sheet Return Instructions on the previous page.*

*Questions? Contact us 8 am-4:30 pm EST  
Telephone: +1-571-434-1925  
email: [forensics@cts-interlab.com](mailto:forensics@cts-interlab.com)*

**Please return all pages of this data sheet.**

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