

San Diego Police Department Crime Laboratory

Forensic Biology Unit

Validation of the Crime-lite® Auto ALS

Introduction

The San Diego Police Department (SDPD) Crime Laboratory's Forensic Biology Unit currently utilizes the benchtop Foster + Freeman Crime-lite® ML Alternate Light Sources (ALS). The laboratory utilizes a Blue-Green (460-510 nm) emission Crime-lite® ML with orange goggles in one examination room and a Blue (430-470 nm) emission Crime-lite® ML with yellow goggles in a second examination room. These Crime-lite® MLs have a limited range of functions--only the one range of colored light (460-510 nm for the Blue-Green ALS or 430-470 nm for the Blue ALS) and white light may be emitted from each device (other emission wavelengths cannot be achieved). The two Crime-lite® MLs are mounted in separate rooms, so it is typical for an analyst to use either the Blue-Green light only OR the Blue light only, not both. The disadvantage of such set-up in the SDPD Crime Lab is that best results are obtained by scanning a range of wavelengths to uncover the maximum amount of potential evidence¹. Even if an analyst were to change rooms mid-examination to utilize the other ALS, which in and of itself is unlikely, the range of wavelengths is still limited; the UV and IR ranges are unachievable, as well as the remaining range of the visual spectrum from 395-430 nm and 510-660 nm.

The Foster + Freeman Crime-lite® Auto is a compact ALS that combines a camera, crime lite illumination, and filtration. This all-in-one device allows an analyst to search, locate, photograph, and/or videotape evidence. The Crime-lite® Auto illumination covers a wide spectra of light wavelengths built in to the device: UV light (350-380 nm), all light in the visible spectrum (395-660 nm), IR light (800-900 nm), and white light. Another feature of the Crime-lite® Auto is the capability of selecting 2 different light sources at once.

The purpose of this validation is to confirm the utility of the Crime-lite® Auto for forensic casework at the SDPD Crime Laboratory.

Materials and Methods

Materials

- Crime-lite® Auto ALS
- Crime-lite® ML ALSes (Blue and Blue-Green)
- Known semen (Lot #39382)
- Known saliva (from self, EAW)
- Known urine (Lot #437)
- Known blood (Lot #22315)
- PCR-grade water
- White cotton and polyester fabrics
- Black cotton and polyester fabrics
- Patterned cotton and polyester fabrics
- Denim
- Lotion
- Sublime Bronze Luminous Bronzer
- Vaseline
- Cholula
- Tomato paste
- Coca Cola
- GSR from a 9mm Glock Handgun from various ranges (6, 12, and 36 inches)

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Methods

Neat semen, saliva, urine, and blood were obtained and the following dilutions were made for each body fluid with PCR-grade water: 1:5, 1:10, 1:20, 1:50, 1:75, 1:100, 1:150, and 1:200.

These neat and diluted body fluid samples were used to make the following mixed biological samples: semen + blood (neat), semen + blood (1:50), saliva + blood (neat), saliva + blood (1:50), urine + blood (neat), urine + blood (1:50), semen + saliva + blood (neat), semen + saliva + blood (1:50), semen + saliva + urine + blood (neat), and semen + saliva + urine + blood (1:50). These body fluids were mixed in an equal proportion to make the mixtures.

200 µL of neat and dilute semen, saliva, and urine were spotted onto each fabric and allowed to dry overnight. Blood was spotted onto the dark fabrics only (black fabrics and standard blue denim) and allowed to dry overnight. Each fabric was viewed under Crime-lite® ML Blue-Green with orange goggles and the results were recorded as positive or negative. Positive results were qualified, when applicable, as strong or weak. Each fabric was subsequently viewed under Crime-lite® ML Blue with yellow goggles and the results were recorded as positive or negative. Positive results were qualified, when applicable, as strong or weak. Finally, each fabric was viewed with the Crime-lite® Auto over a range of wavelengths, according to the recommendations in Figure 1 below (photo taken from the Crime-lite® Auto manual). However, only one light source was used at a time. Blood results under white light were not explicitly recorded since standard procedure in the laboratory entails observation of all items of evidence under white light. The fabrics were viewed with the filter automatically selected by the Crime-lite® Auto. Results were recorded as positive or negative and positive results were qualified, when applicable, as strong or weak.

200 µL of mixed biologicals were spotted onto the white and black fabrics only and allowed to dry overnight. Each fabric was viewed under Crime-lite® ML Blue-Green with orange goggles and the results were recorded as positive or negative. Positive results were qualified, when applicable, as strong or weak. Each fabric was subsequently viewed under Crime-lite® ML Blue with yellow goggles and the results were recorded as positive or negative. Positive results were qualified, when applicable, as strong or weak. Finally, each fabric was viewed with the Crime-lite® Auto over a range of wavelengths, according to the recommendations in Figure 1 below (photo taken from the Crime-lite® Auto manual). However, only one light source was used at a time. The fabrics were viewed with the filter automatically selected by the Crime-lite® Auto. Results were recorded as positive or negative and positive results were qualified, when applicable, as strong or weak.

Lotion, bronzer, Vaseline, Cholula, tomato paste, and Coca Cola were spotted onto each fabric and allowed to dry overnight. The lotion, bronzer, Vaseline, Cholula, and tomato paste were spotted onto the fabrics by saturating a cotton swab with the non-biological samples, then rubbing the cotton swab onto each fabric in an ~1 in x 1 in circle. A pipette was used to spot 200 µL of Coca Cola onto each fabric. Fluorescent examination was followed according to the methods described above. The Crime-lite® Auto wavelengths selected were the same as those used to examine the biological dilution series and mixed biological samples to assess instances of false positives.

Gunshot Residue (GSR) evidence was prepared by the SDPD Crime Lab's Firearms unit. Four types of material were chosen to look for gunshot residue after a 9mm Glock handgun was fired from close, medium, and far distances. The materials chosen consisted of white polyester, black cotton, patterned cotton, and denim. The material was attached to the backstop. Tape was placed on the floor of the shooting room at a distance of 6 inches, 12 inches, and 36 inches from the target. The muzzle of the gun was held above the tape for firing for each material type.

Selecting a light source


| | |  | White 400 – 700 nm | Ultraviolet 350 – 380 +1 nm | Violet 395 – 425 +1.2 nm | Blue 420 – 470 nm | Blue-Green 445 – 510 nm | Green 480 – 550 nm | Orange 570 – 610 nm | Red 600 – 660 nm | Infrared 800 – 900 nm |
|----------------|--------------------|---|-----------------------|--------------------------------|-----------------------------|----------------------|----------------------------|-----------------------|------------------------|---------------------|--------------------------|
| Trace evidence | Untreated evidence | Blood stains | | | | | | | | | |
| | | Blood spatter | | | | | | | | | |
| | | Body bruising; Bite marks | | | | | | | | | |
| | | Body fluids | | | | | | | | | |
| | | Gunshot residues; Smoke traces | | | | | | | | | |
| | | Fibres | | | | | | | | | |
| | | Hair | | | | | | | | | |
| | | Latent fingerprints | | | | | | | | | |
| | | Bone fragments; Tooth fragments | | | | | | | | | |
| | | Some drug residues | | | | | | | | | |
| | | General mixed debris | | | | | | | | | |
| | | Nanoparticles | | | | | | | | | |
| | | Fire accelerants | | | | | | | | | |
| | Treated evidence | DFO (1,8-Diazafluoren-9-one) | | | | | | | | | |
| | | Redwop | | | | | | | | | |
| | | Greenwop | | | | | | | | | |
| | | Rhodamine 6G | | | | | | | | | |
| | | Basic yellow | | | | | | | | | |
| | | Acid yellow | | | | | | | | | |
| | | Ardrox | | | | | | | | | |
| | | Magnetic red powder | | | | | | | | | |
| | | Ninhydrin | | | | | | | | | |
| | | fpNatural® 1 | | | | | | | | | |
| | | fpNatural® 2 | | | | | | | | | |

Figure 1: Image from the Crime-lite® Auto user's manual outlining the manufacturer's recommendations for choosing an illumination light source based on sample type.

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Results

In the tables below, entries highlighted in green have more intense fluorescence than the existing Crime-lite MLs. Entries highlighted in blue have less intense fluorescence than the existing Crime-lite MLs. For instance, the 1:200 semen on black cotton, both the Crime-lite® ML Blue-Green and the Crime-lite® ML Blue had no detectable fluorescence (negative) at this dilution. However, weak fluorescence could be visualized with the Crime-lite® Auto Blue light. Therefore, this entry is highlighted green for the improved fluorescence intensity in comparison to the currently used ALSes.

On the other hand, the 1:150 semen on white cotton displayed weak fluorescence with both the Crime-lite® ML Blue-Green and the Crime-lite® ML Blue. However, there was no detectable fluorescence (negative) with the Crime-lite® Auto Blue light. Therefore, this entry is highlighted blue for the weaker fluorescence intensity in comparison to the currently used ALSes.

It is critical to note that in the above scenarios, the Crime-lite® ML Blue-Green and the Crime-lite® ML Blue performed the same as each other (both were negative or both were weak positive). This was not always the case. Entries for the Crime-lite® Auto are only highlighted in green if the fluorescence intensity was increased in comparison to BOTH the Crime-lite® ML Blue-Green and the Crime-lite® ML Blue. For example, if a sample is recorded as **positive** with the Crime-lite® ML Blue-Green and **weak positive** with the Crime-lite® ML Blue, but **strong positive** with the Crime-lite® Auto, this entry for the Crime-lite® Auto would be highlighted green. But, in the same scenario, if the sample was **positive** with the Crime-lite® Auto, because this fluorescence intensity is the same as the intensity for the Crime-lite® ML Blue-Green, it is *un-highlighted* for equivalent performance (it is un-highlighted even though positive is more intense than Crime-lite® ML Blue, it does not surpass the intensity seen for *both* lights). The same idea applies to entries highlighted in blue. If a sample is recorded as **positive** with the Crime-lite® ML Blue-Green and **weak positive** with the Crime-lite® ML Blue, but **negative** with the Crime-lite® Auto, this entry for the Crime-lite® Auto would be highlighted blue. But, in the same scenario, if the sample was **weak positive** with the Crime-lite® Auto, because this fluorescence intensity is the same as the intensity for the Crime-lite® ML Blue, it is *un-highlighted* for equivalent performance (it is un-highlighted even though weak positive is less intense than Crime-lite® ML Blue-Green, it is not less intense than what is seen for *both* lights).

Semen

Observing semen stains with the Crime-lite® Auto Blue light, there were two samples (3.2%) with more intense fluorescence than the existing methods, and two samples (3.2%) with less intense fluorescence than the existing methods (Table 1). One of the two decreased intensity samples was negative. Overall, performance is comparable.

Observing semen stains with the Crime-lite® Auto Violet, there were 22 samples (35%) displaying less intense fluorescence than the existing methods (Table 2). 21 of these samples were negative. Overall, performance is reduced.

Observing semen stains with the Crime-lite® Auto Ultraviolet arm lights, there were 30 samples (47.6%) displaying less intense detection than the existing methods (Table 3). 25 of these samples were negative. Body fluid stains observed with the UV arm lights are presented in grayscale, and therefore do not "fluoresce"; rather, a spot is visible. Overall, performance is reduced.

Observing semen stains with the Crime-lite® Auto Ultraviolet lens, there were 28 samples (44.4%) displaying less intense detection than the existing methods (Table 4). 20 of these samples were negative. Overall, performance is reduced.

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Table 1: Semen Crime-lite Auto, Blue

| Dilution | White Cotton | White Polyester | Black Cotton | Black Polyester | Patterned Cotton | Patterned Polyester | Denim |
|----------|-----------------|-----------------|-----------------|-----------------|------------------|---------------------|-----------------|
| Neat | strong positive | strong positive | strong positive | negative | strong positive | strong positive | strong positive |
| 1:5 | positive | positive | weak positive | negative | positive | weak positive | positive |
| 1:10 | positive | positive | weak positive | negative | positive | negative | positive |
| 1:20 | positive | positive | weak positive | negative | weak positive | negative | weak positive |
| 1:50 | weak positive | weak positive | weak positive | negative | weak positive | negative | weak positive |
| 1:75 | weak positive | negative | weak positive | negative | weak positive | negative | weak positive |
| 1:100 | weak positive | negative | weak positive | negative | negative | negative | weak positive |
| 1:150 | negative | negative | weak positive | negative | negative | negative | weak positive |
| 1:200 | weak positive | negative | weak positive | negative | negative | negative | weak positive |

Table 2: Semen Crime-lite Auto, Violet

| Dilution | White Cotton | White Polyester | Black Cotton | Black Polyester | Patterned Cotton | Patterned Polyester | Denim |
|----------|---------------|-----------------|--------------|-----------------|------------------|---------------------|---------------|
| Neat | positive | strong positive | positive | negative | positive | negative | weak positive |
| 1:5 | weak positive | weak positive | negative | negative | negative | negative | weak positive |
| 1:10 | weak positive | negative | negative | negative | negative | negative | negative |
| 1:20 | weak positive | negative | negative | negative | negative | negative | negative |
| 1:50 | negative | negative | negative | negative | negative | negative | negative |
| 1:75 | weak positive | negative | negative | negative | negative | negative | negative |
| 1:100 | weak positive | negative | negative | negative | negative | negative | negative |
| 1:150 | negative | negative | negative | negative | negative | negative | negative |
| 1:200 | weak positive | negative | negative | negative | negative | negative | negative |

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Table 3: Semen Crime-lite Auto, Ultraviolet Arms

| Dilution | White Cotton | White Polyester | Black Cotton | Black Polyester | Patterned Cotton | Patterned Polyester | Denim |
|-----------------|---------------------|------------------------|---------------------|------------------------|-------------------------|----------------------------|--------------|
| Neat | positive | strong positive | positive | negative | positive | weak positive | positive |
| 1:5 | weak positive | weak positive | negative | negative | negative | negative | negative |
| 1:10 | negative | negative | negative | negative | negative | negative | negative |
| 1:20 | negative | negative | negative | negative | negative | negative | negative |
| 1:50 | negative | negative | negative | negative | negative | negative | negative |
| 1:75 | negative | negative | negative | negative | negative | negative | negative |
| 1:100 | negative | negative | negative | negative | negative | negative | negative |
| 1:150 | negative | negative | negative | negative | negative | negative | negative |
| 1:200 | negative | negative | negative | negative | negative | negative | negative |

Table 4: Semen Crime-lite Auto, Ultraviolet Lens

| Dilution | White Cotton | White Polyester | Black Cotton | Black Polyester | Patterned Cotton | Patterned Polyester | Denim |
|-----------------|---------------------|------------------------|---------------------|------------------------|-------------------------|----------------------------|--------------|
| Neat | positive | positive | weak positive | negative | weak positive | negative | negative |
| 1:5 | weak positive | weak positive | negative | negative | negative | negative | negative |
| 1:10 | weak positive | negative | negative | negative | negative | negative | negative |
| 1:20 | weak positive | negative | negative | negative | negative | negative | negative |
| 1:50 | weak positive | negative | negative | negative | negative | negative | negative |
| 1:75 | weak positive | negative | negative | negative | negative | negative | negative |
| 1:100 | weak positive | negative | negative | negative | negative | negative | negative |
| 1:150 | weak positive | negative | negative | negative | negative | negative | negative |
| 1:200 | weak positive | negative | negative | negative | negative | negative | negative |

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Saliva

Observing saliva stains with the Crime-lite® Auto Blue light, there were five samples (7.9%) with more intense fluorescence than the existing methods, and one sample (1.6%) with less intense fluorescence than the existing methods (Table 5). The sample with less intense fluorescence was still detectable with the Crime-lite® Auto Blue. Therefore, performance is improved with the Crime-lite® Auto Blue versus the existing methods.

Observing saliva stains with the Crime-lite® Auto Violet, there were nine samples (14.3%) displaying less intense fluorescence than the existing methods (Table 6). All nine of these samples were negative. Overall, performance is reduced.

Observing saliva stains with the Crime-lite® Auto Ultraviolet arm lights, there were 18 samples (28.6%) displaying less intense detection than the existing methods (Table 7). All 18 of these samples were negative. Overall, performance is reduced.

Observing saliva stains with the Crime-lite® Auto Ultraviolet lens, there were 10 samples (15.9%) displaying less intense detection than the existing methods (Table 8). Nine of these samples were negative. Overall, performance is reduced.

Table 5: Saliva Crime-lite Auto, Blue

| Dilution | White Cotton | White Polyester | Black Cotton | Black Polyester | Patterned Cotton | Patterned Polyester | Denim |
|-----------------|---------------------|------------------------|---------------------|------------------------|-------------------------|----------------------------|---------------|
| Neat | weak positive | negative | weak positive | negative | weak positive | negative | positive |
| 1:5 | weak positive | negative | weak positive | negative | weak positive | negative | weak positive |
| 1:10 | weak positive | negative | weak positive | negative | weak positive | negative | weak positive |
| 1:20 | weak positive | negative | weak positive | negative | weak positive | weak positive | positive |
| 1:50 | weak positive | negative | weak positive | negative | negative | negative | weak positive |
| 1:75 | weak positive | negative | weak positive | negative | negative | negative | weak positive |
| 1:100 | weak positive | negative | weak positive | negative | negative | negative | weak positive |
| 1:150 | weak positive | negative | weak positive | negative | negative | negative | positive |
| 1:200 | weak positive | negative | weak positive | negative | negative | negative | weak positive |

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| Dilution | White Cotton | White Polyester | Black Cotton | Black Polyester | Patterned Cotton | Patterned Polyester | Denim |
|----------|---------------|-----------------|---------------|-----------------|------------------|---------------------|----------|
| Neat | negative | negative | weak positive | negative | negative | negative | negative |
| 1:5 | weak positive | negative | weak positive | negative | negative | negative | negative |
| 1:10 | weak positive | negative | weak positive | negative | negative | negative | negative |
| 1:20 | weak positive | negative | weak positive | negative | negative | negative | negative |
| 1:50 | weak positive | negative | weak positive | negative | negative | negative | negative |
| 1:75 | weak positive | negative | weak positive | negative | negative | negative | negative |
| 1:100 | weak positive | negative | negative | negative | negative | negative | negative |
| 1:150 | weak positive | negative | negative | negative | negative | negative | negative |
| 1:200 | weak positive | negative | negative | negative | negative | negative | negative |

[illegible]

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Table 8: Saliva Crime-lite Auto, Ultraviolet Lens

| Dilution | White Cotton | White Polyester | Black Cotton | Black Polyester | Patterned Cotton | Patterned Polyester | Denim |
|-----------------|---------------------|------------------------|---------------------|------------------------|-------------------------|----------------------------|--------------|
| Neat | weak positive | negative | weak positive | negative | negative | negative | negative |
| 1:5 | weak positive | negative | negative | negative | negative | negative | negative |
| 1:10 | weak positive | negative | negative | negative | negative | negative | negative |
| 1:20 | weak positive | negative | negative | negative | negative | negative | negative |
| 1:50 | weak positive | negative | negative | negative | negative | negative | negative |
| 1:75 | weak positive | negative | negative | negative | negative | negative | negative |
| 1:100 | weak positive | negative | negative | negative | negative | negative | negative |
| 1:150 | weak positive | negative | negative | negative | negative | negative | negative |
| 1:200 | weak positive | negative | negative | negative | negative | negative | negative |

Urine

Observing urine stains with the Crime-lite® Auto Blue light, there were two samples (3.2%) with more intense fluorescence than the existing methods, and three samples (4.7%) with less intense fluorescence than the existing methods (Table 9). All three of the less intense samples were negative. Overall, performance is comparable/slightly reduced.

Observing urine stains with the Crime-lite® Auto Violet, there were 18 samples (28.6%) displaying less intense fluorescence than the existing methods (Table 10). All 18 of these samples were negative. Overall, performance reduced.

Observing urine stains with the Crime-lite® Auto Ultraviolet arm lights, there were 21 samples (33.3%) displaying less intense detection than the existing methods (Table 11). 19 of these samples were negative. Overall, performance is reduced.

Observing urine stains with the Crime-lite® Auto Ultraviolet lens, there were 20 samples (31.7%) displaying less intense detection than the existing methods (Table 12). 18 of these samples were negative. Overall, performance is reduced.

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Table 9: Urine Crime-lite Auto, Blue

| Dilution | White Cotton | White Polyester | Black Cotton | Black Polyester | Patterned Cotton | Patterned Polyester | Denim |
|----------|-----------------|-----------------|---------------|-----------------|------------------|---------------------|---------------|
| Neat | strong positive | positive | negative | negative | positive | weak positive | positive |
| 1:5 | positive | weak positive | weak positive | negative | weak positive | negative | weak positive |
| 1:10 | positive | weak positive | weak positive | negative | weak positive | negative | weak positive |
| 1:20 | weak positive | negative | weak positive | negative | weak positive | negative | weak positive |
| 1:50 | weak positive | negative | weak positive | negative | negative | negative | weak positive |
| 1:75 | weak positive | negative | weak positive | negative | weak positive | negative | weak positive |
| 1:100 | weak positive | negative | weak positive | negative | weak positive | negative | weak positive |
| 1:150 | weak positive | negative | weak positive | negative | negative | negative | weak positive |
| 1:200 | weak positive | negative | weak positive | negative | negative | negative | weak positive |

Table 10: Urine Crime-lite Auto, Violet

| Dilution | White Cotton | White Polyester | Black Cotton | Black Polyester | Patterned Cotton | Patterned Polyester | Denim |
|----------|-----------------|-----------------|---------------|-----------------|------------------|---------------------|----------|
| Neat | strong positive | negative | negative | negative | negative | negative | negative |
| 1:5 | positive | negative | weak positive | negative | negative | negative | negative |
| 1:10 | weak positive | negative | weak positive | negative | negative | negative | negative |
| 1:20 | weak positive | negative | weak positive | negative | negative | negative | negative |
| 1:50 | weak positive | negative | weak positive | negative | negative | negative | negative |
| 1:75 | weak positive | negative | weak positive | negative | negative | negative | negative |
| 1:100 | weak positive | negative | negative | negative | negative | negative | negative |
| 1:150 | weak positive | negative | negative | negative | negative | negative | negative |
| 1:200 | weak positive | negative | negative | negative | negative | negative | negative |

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Table 11: Urine Crime-lite Auto, Ultraviolet Arms

| Dilution | White Cotton | White Polyester | Black Cotton | Black Polyester | Patterned Cotton | Patterned Polyester | Denim |
|-----------------|---------------------|------------------------|---------------------|------------------------|-------------------------|----------------------------|---------------|
| Neat | negative | weak positive | negative | negative | negative | negative | weak positive |
| 1:5 | negative | weak positive | negative | negative | negative | negative | weak positive |
| 1:10 | negative | weak positive | negative | negative | negative | negative | weak positive |
| 1:20 | negative | negative | negative | negative | negative | negative | negative |
| 1:50 | negative | negative | negative | negative | negative | negative | weak positive |
| 1:75 | negative | negative | negative | negative | negative | negative | weak positive |
| 1:100 | negative | negative | negative | negative | negative | negative | negative |
| 1:150 | negative | negative | negative | negative | negative | negative | negative |
| 1:200 | negative | negative | negative | negative | negative | negative | negative |

Table 12: Urine Crime-lite Auto, Ultraviolet Lens

| Dilution | White Cotton | White Polyester | Black Cotton | Black Polyester | Patterned Cotton | Patterned Polyester | Denim |
|-----------------|---------------------|------------------------|---------------------|------------------------|-------------------------|----------------------------|--------------|
| Neat | positive | negative | negative | negative | negative | negative | negative |
| 1:5 | weak positive | negative | negative | negative | negative | negative | negative |
| 1:10 | weak positive | negative | negative | negative | negative | negative | negative |
| 1:20 | weak positive | negative | negative | negative | negative | negative | negative |
| 1:50 | weak positive | negative | negative | negative | negative | negative | negative |
| 1:75 | weak positive | negative | negative | negative | negative | negative | negative |
| 1:100 | weak positive | negative | negative | negative | negative | negative | negative |
| 1:150 | weak positive | negative | negative | negative | negative | negative | negative |
| 1:200 | weak positive | negative | negative | negative | negative | negative | negative |

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Blood

Observing blood stains with the Crime-lite® Auto Blue light, there were six samples (22.2%) with more intense fluorescence than the existing methods, and no samples with less intense fluorescence than the existing methods (Table 13). Overall, performance is improved with the Crime-lite® Auto Blue versus the existing methods.

Observing blood stains with the Crime-lite® Auto Violet, there were three samples (11%) with more intense fluorescence than the existing methods, and seven samples (25.9%) with less intense fluorescence than the existing methods (Table 14). All 7 of these samples were negative. Overall, performance is reduced with the Crime-lite® Auto Violet versus the existing methods.

Observing blood stains with the Crime-lite® Auto IR, there were 10 samples (37%) with enhanced detection capabilities than the existing methods, and five samples (18.5%) with less intense detecting capabilities than the existing methods (Table 15). All 5 of these samples were negative. Blood stains on dark fabric do not “fluoresce” under IR light; rather, the background fabric appears lighter and the bloodstain appears as a dark spot. Overall, performance is improved with the Crime-lite® Auto IR.

Table 13: Blood Crime-lite Auto, Blue

| Dilution | Black Cotton | Black Polyester | Denim |
|----------|---------------|-----------------|---------------|
| Neat | negative | negative | negative |
| 1:5 | negative | negative | negative |
| 1:10 | negative | negative | weak positive |
| 1:20 | weak positive | negative | weak positive |
| 1:50 | weak positive | negative | weak positive |
| 1:75 | weak positive | negative | weak positive |
| 1:100 | weak positive | negative | weak positive |
| 1:150 | weak positive | negative | weak positive |
| 1:200 | weak positive | negative | weak positive |

Table 14: Blood Crime-lite Auto, Violet

| Dilution | Black Cotton | Black Polyester | Denim |
|----------|---------------|-----------------|----------|
| Neat | negative | negative | negative |
| 1:5 | negative | negative | negative |
| 1:10 | negative | negative | negative |
| 1:20 | weak positive | negative | negative |
| 1:50 | weak positive | negative | negative |
| 1:75 | weak positive | negative | negative |
| 1:100 | negative | negative | negative |
| 1:150 | negative | negative | negative |
| 1:200 | negative | negative | negative |

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| Table 15: Blood Crime-lite Auto, IR | | | |
|-------------------------------------|-----------------|-----------------|-----------------|
| Dilution | Black Cotton | Black Polyester | Denim |
| Neat | strong positive | strong positive | strong positive |
| 1:5 | positive | weak positive | positive |
| 1:10 | positive | weak positive | weak positive |
| 1:20 | weak positive | weak positive | weak positive |
| 1:50 | negative | negative | negative |
| 1:75 | negative | negative | negative |
| 1:100 | negative | negative | negative |
| 1:150 | negative | negative | negative |
| 1:200 | negative | negative | negative |

Mixed Biologicals

Observing mixed biological stains with the Crime-lite® Auto Blue light, there were four samples (10%) with more intense fluorescence than the existing methods, and four samples (10%) with less intense fluorescence than the existing methods (Table 16). All samples with less intense fluorescence were still detectable with the Crime-lite® Auto Blue. Overall, performance is comparable.

Observing mixed biological stains with the Crime-lite® Auto Violet, there were five samples (12.5%) with less intense fluorescence than the existing methods (Table 17). All five of these samples were negative. Overall, performance is reduced.

Observing mixed biological stains with the Crime-lite® Auto IR, there were 10 samples (50%) with enhanced detection capabilities than the existing methods, and no samples with less intense detecting capabilities than the existing methods (Table 18). Therefore, performance is improved with the Crime-lite® Auto IR versus the existing methods.

Observing mixed biological stains with the Crime-lite® Auto Ultraviolet arm lights, there were 25 samples (62.5%) with enhanced detection capabilities than the existing methods, and five samples (12.5%) with less intense detecting capabilities than the existing methods (Table 19). Therefore, performance is improved with the Crime-lite® Auto Ultraviolet arm lights versus the existing methods.

Observing mixed biological stains with the Crime-lite® Auto Ultraviolet lens, there were 13 samples (32.5%) with enhanced detection capabilities than the existing methods, and no samples with less intense detecting capabilities than the existing methods (Table 20). Therefore, performance is improved with the Crime-lite® Auto Ultraviolet lens versus the existing methods.

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| Table 16: Mixed Biologicals Crime-lite Auto, Blue | | | | |
|--|---------------------|------------------------|---------------------|------------------------|
| Mixture | White Cotton | White Polyester | Black Cotton | Black Polyester |
| Semen + Blood (neat) | negative | negative | positive | negative |
| Semen + Blood (1:50) | weak positive | negative | weak positive | negative |
| Saliva + Blood (neat) | negative | negative | positive | negative |
| Saliva + Blood (1:50) | weak positive | negative | negative | negative |
| Urine + Blood (neat) | negative | negative | positive | negative |
| Urine + Blood (1:50) | weak positive | negative | weak positive | negative |
| Semen + Saliva + Blood (neat) | negative | negative | negative | negative |
| Semen + Saliva + Blood (1:50) | weak positive | negative | weak positive | negative |
| Semen + Saliva + Urine + Blood (neat) | negative | negative | negative | negative |
| Semen + Saliva + Urine + Blood (1:50) | weak positive | negative | weak positive | negative |

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Table 17: Mixed Biologicals Crime-lite Auto, Violet

| Mixture | White Cotton | White Polyester | Black Cotton | Black Polyester |
|---|---------------------|------------------------|---------------------|------------------------|
| Semen + Blood (neat) | negative | negative | negative | negative |
| Semen + Blood (1:50) | negative | negative | negative | negative |
| Saliva + Blood (neat) | negative | negative | negative | negative |
| Saliva + Blood (1:50) | negative | negative | negative | negative |
| Urine + Blood (neat) | negative | negative | negative | negative |
| Urine + Blood (1:50) | negative | negative | negative | negative |
| Semen + Saliva + Blood (neat) | negative | negative | negative | negative |
| Semen + Saliva + Blood (1:50) | negative | negative | negative | negative |
| Semen + Saliva + Urine + Blood (neat) | negative | negative | negative | negative |
| Semen + Saliva + Urine + Blood (1:50) | negative | negative | negative | negative |

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| Table 18: Mixed Biologicals Crime-lite Auto, IR | | |
|--|---------------------|------------------------|
| Mixture | Black Cotton | Black Polyester |
| Semen + Blood (neat) | strong positive | positive |
| Semen + Blood (1:50) | negative | negative |
| Saliva + Blood (neat) | strong positive | positive |
| Saliva + Blood (1:50) | negative | negative |
| Urine + Blood (neat) | strong positive | positive |
| Urine + Blood (1:50) | negative | negative |
| Semen + Saliva + Blood (neat) | positive | positive |
| Semen + Saliva + Blood (1:50) | negative | negative |
| Semen + Saliva + Urine + Blood (neat) | positive | positive |
| Semen + Saliva + Urine + Blood (1:50) | negative | negative |

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Table 19: Mixed Biologicals Crime-lite Auto, Ultraviolet Arms

| Mixture | White Cotton | White Polyester | Black Cotton | Black Polyester |
|---|---------------------|------------------------|---------------------|------------------------|
| Semen + Blood (neat) | strong positive | strong positive | positive | weak positive |
| Semen + Blood (1:50) | negative | positive | negative | negative |
| Saliva + Blood (neat) | strong positive | strong positive | positive | weak positive |
| Saliva + Blood (1:50) | negative | positive | negative | negative |
| Urine + Blood (neat) | strong positive | strong positive | positive | weak positive |
| Urine + Blood (1:50) | negative | positive | negative | negative |
| Semen + Saliva + Blood (neat) | strong positive | strong positive | positive | weak positive |
| Semen + Saliva + Blood (1:50) | negative | positive | negative | negative |
| Semen + Saliva + Urine + Blood (neat) | strong positive | strong positive | positive | weak positive |
| Semen + Saliva + Urine + Blood (1:50) | negative | positive | negative | negative |

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| Table 20: Mixed Biologicals Crime-lite Auto, Ultraviolet Lens | | | | |
|--|---------------------|------------------------|---------------------|------------------------|
| Mixture | White Cotton | White Polyester | Black Cotton | Black Polyester |
| Semen + Blood (neat) | strong positive | strong positive | negative | negative |
| Semen + Blood (1:50) | positive | weak positive | negative | negative |
| Saliva + Blood (neat) | strong positive | strong positive | negative | negative |
| Saliva + Blood (1:50) | positive | weak positive | negative | negative |
| Urine + Blood (neat) | strong positive | strong positive | negative | negative |
| Urine + Blood (1:50) | positive | weak positive | negative | negative |
| Semen + Saliva + Blood (neat) | strong positive | strong positive | negative | negative |
| Semen + Saliva + Blood (1:50) | positive | negative | negative | negative |
| Semen + Saliva + Urine + Blood (neat) | strong positive | strong positive | negative | negative |
| Semen + Saliva + Urine + Blood (1:50) | positive | negative | negative | negative |

Non-biologicals

Observing non-biological stains with the Crime-lite® Auto Blue light, there were two samples (4.8%) with more intense fluorescence than the existing methods, and one sample (2.4%) with less intense fluorescence than the existing methods (Table 21). Overall, performance is comparable.

Observing non-biological stains with the Crime-lite® Auto Violet, there were 22 samples (52.4%) displaying less intense fluorescence than the existing methods (Table 22). 20 of these samples were negative. This is considered improved performance.

Observing non-biological stains with the IR light on the Crime-lite® Auto, there were three samples (16.7%) with enhanced detection capabilities than the existing methods, and 12 samples (66.7%) with less intense detecting capabilities than the existing methods (Table 23). This is considered improved performance.

Observing non-biological stains with the UV arm lights on the Crime-lite® Auto, there were nine samples (21.4%) with enhanced detection capabilities than the existing methods, and five samples (11.9%) with less intense detecting capabilities than the existing methods (Table 24). This is considered a decrease in performance.

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Observing non-biological stains with the UV lens light on the Crime-lite® Auto, there were four samples (9.5%) with enhanced detection capabilities than the existing methods, and 10 samples (23.8%) with less intense detecting capabilities than the existing methods (Table 25). This is considered improved performance.

Table 21: Non-Biologicals Crime-lite Auto, Blue

| Sample | White Cotton | White Polyester | Black Cotton | Black Polyester | Patterned Cotton | Patterned Polyester | Denim |
|--------------|-----------------|-----------------|-----------------|-----------------|------------------|---------------------|-----------------|
| Lotion | weak positive | weak positive | weak positive | negative | positive | weak positive | weak positive |
| Vaseline | negative | negative | negative | negative | negative | negative | negative |
| Bronzer | strong positive | negative | strong positive | weak positive | strong positive | negative | strong positive |
| Cholula | strong positive | strong positive | strong positive | strong positive | strong positive | negative | strong positive |
| Tomato Paste | strong positive | strong positive | strong positive | strong positive | strong positive | strong positive | strong positive |
| Coca Cola | positive | positive | positive | negative | positive | negative | positive |

Table 22: Non-Biologicals Crime-lite Auto, Violet

| Sample | White Cotton | White Polyester | Black Cotton | Black Polyester | Patterned Cotton | Patterned Polyester | Denim |
|--------------|---------------|-----------------|-----------------|-----------------|------------------|---------------------|----------|
| Lotion | negative | negative | weak positive | negative | weak positive | negative | negative |
| Vaseline | negative | negative | negative | negative | negative | negative | negative |
| Bronzer | negative | negative | positive | negative | negative | negative | negative |
| Cholula | negative | positive | strong positive | negative | negative | negative | negative |
| Tomato Paste | negative | negative | strong positive | negative | negative | negative | negative |
| Coca Cola | weak positive | negative | weak positive | negative | negative | negative | negative |

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| Table 23: Non-Biologicals Crime-lite Auto, IR | | | |
|--|---------------------|------------------------|---------------|
| Dilution | Black Cotton | Black Polyester | Denim |
| Lotion | negative | weak positive | negative |
| Vaseline | negative | negative | weak positive |
| Bronzer | negative | weak positive | negative |
| Cholula | negative | weak positive | negative |
| Tomato Paste | negative | weak positive | negative |
| Coca Cola | negative | weak positive | negative |

| Table 24: Non-Biologicals Crime-lite Auto, Ultraviolet Arms | | | | | | | |
|--|---------------------|------------------------|---------------------|------------------------|-------------------------|----------------------------|-----------------|
| Sample | White Cotton | White Polyester | Black Cotton | Black Polyester | Patterned Cotton | Patterned Polyester | Denim |
| Lotion | weak positive | weak positive | positive | weak positive | weak positive | negative | negative |
| Vaseline | positive | negative | weak positive | negative | positive | negative | positive |
| Bronzer | strong positive | strong positive | strong positive | positive | strong positive | positive | strong positive |
| Cholula | positive | strong positive | strong positive | positive | strong positive | weak positive | positive |
| Tomato Paste | strong positive | strong positive | strong positive | strong positive | strong positive | strong positive | strong positive |
| Coca Cola | weak positive | positive | negative | weak positive | positive | negative | weak positive |

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| Table 25: Non-Biologicals Crime-lite Auto, Ultraviolet Lens | | | | | | | |
|---|-----------------|-----------------|-----------------|-----------------|------------------|---------------------|-----------------|
| Sample | White Cotton | White Polyester | Black Cotton | Black Polyester | Patterned Cotton | Patterned Polyester | Denim |
| Lotion | weak positive | weak positive | weak positive | weak positive | negative | negative | negative |
| Vaseline | negative | weak positive | weak positive | positive | negative | negative | negative |
| Bronzer | strong positive | strong positive | strong positive | negative | strong positive | negative | strong positive |
| Cholula | strong positive | strong positive | strong positive | weak positive | strong positive | weak positive | positive |
| Tomato Paste | strong positive | strong positive | negative | strong positive | strong positive | strong positive | strong positive |
| Coca Cola | positive | weak positive | negative | negative | negative | negative | negative |

GSR

GSR samples were analyzed by individuals in the SDPD Firearms unit. The firearms unit found that the GSR was visible on the material at 6 inches for each type of material. It was visible on all material but the black cloth at 12 inches. Using the Crime-lite® Auto Blue-Green, Crime-lite® Auto Blue, and Crime-lite® Auto IR settings, it was found that all GSR was better visualized at every distance on the material.

The small gunshot particles were only visible at 36 inches with the Crime-lite® Auto IR. The Crime-lite® Auto IR was the best to visualize GSR on patterned and black materials as well. GSR on white materials could be seen with the naked eye, however was still better visualized using the Crime-lite® Auto.

Conclusions

Independent of performance, the Crime-lite® Auto is easier to use and maneuver than the Crime-lite® MLs. Because the Crime-lite® MLs are mounted on arms, the borders of the examination table receive a weak illumination source. This has shown to be problematic with large items, like bedding. Bedding may occupy the entire examination table, and therefore requires more evidence maneuvering to strongly illuminate all areas. Because it is best to handle an item as little as possible, this is a drawback of the current set-up. However, the hand-held nature of the Crime-lite® Auto means that instead of moving the item, I just need to move the illumination source myself. This is the preferred method of evidence examination, not only for evidence handling, but also for efficiency. The only downside to the hand-held nature of the Crime-lite® Auto is it can get heavy after an extended period of time, and the battery must be changed fairly often (~2-5 hours, depending on which battery is being used). Therefore, a battery should always be charging on deck. This is not an issue in the laboratory, but may take some consideration at a scene.

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Photographing fluorescence is also vastly easier with the Crime-lite® Auto because the camera is built in to the system. There is no coordination of positioning the ALS for appropriate illumination with the position of the camera/photographer.

Crime-lite® Auto Blue

The Crime-lite® Auto Blue showed improved performance in comparison to the existing Crime-lite® MLs throughout this experiment as a whole.

However, there were some areas of concern with the Crime-lite® Auto Blue's detection of biological material: for one semen stain and three urine stains, the Crime-lite® Auto Blue yielded a negative result when the Crime-lite® MLs could detect some intensity of fluorescence for these same samples. One of these urine stains (1:20 on white polyester) with detectable fluorescence with the Crime-lite® MLs was noted to be positive only because I knew where to look for the stain; in a real casework scenario, with no indication of where body fluids may have been deposited, this stain probably would not have been located. Therefore, it could be argued that this sample is not well suited for performance comparison.

The Crime-lite® Auto Blue was used to observe 256 body fluid stains on an assortment of fabric types. There were only 4/256 (1.6%) instances where the Crime-lite® Auto could not detect fluorescence where fluorescence could otherwise be detected, based on currently used protocols. Oppositely, there were 11/256 (4.3%) instances where the Crime-lite® Auto could detect fluorescence where fluorescence was otherwise undetected with the Crime-lite® MLs.

For non-biologicals, the Crime-lite® Auto Blue performance is comparable to the Crime-lite® MLs. Non-biologicals are still detected by the Crime-lite® Auto Blue, resulting in instances of false positives.

GSR was also better visualized with the Crime-lite® Auto.

Considering these factors above, the Crime-lite® Auto Blue is effective for use in the Forensic Biology and Crime Scene Reconstruction units.

Crime-lite® Auto Violet

The Crime-lite® Auto Violet under-performed the Crime-lite® MLs throughout this entire experiment. 60/256 (23.4%) biological samples yielded a negative result with the Crime-lite® Auto Violet when the Crime-lite® MLs could detect some intensity of fluorescence for these same samples. Some of these samples are the same as above: detectable fluorescence with the Crime-lite® MLs was noted to be positive only because I knew where to look for the stain; in a real casework scenario, with no indication of where body fluids may have been deposited, this stain probably would not have been located. However, this does not account for all 60 samples and, while using the Crime-lite® Auto Violet, it was noticeable how poor its performance was versus the Crime-lite® MLs and Crime-lite® Auto Blue.

For non-biologicals, the Crime-lite® Auto Violet did have improved performance over existing methods. The number of false positives is reduced with the Crime-lite® Auto Violet. However, this should be interpreted with caution because fluorescent detection was reduced overall, across all samples types, not just the non-biologicals.

If the Crime-lite® Auto Violet is to be utilized by the Forensic Biology and Crime Scene Reconstruction units, it should be done in conjunction with the Crime-lite® Auto Blue. Using the violet illumination alone poses too big of a risk in missing true biological material.

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Crime-lite® Auto Blue-Green

The Crime-lite® Auto Blue-Green was only assessed for the detection of GSR. GSR was better visualized with the Crime-lite® Auto than with the naked eye.

Crime-lite® Auto Infrared

Previously, the laboratory has had no IR illumination function. The added capability of IR light on the Crime-lite® Auto was effective at detecting blood and blood-containing mixtures on dark fabrics. In the tables above, the Crime-lite® Auto IR was compared to capabilities of the Crime-lite® MLs for consistency purposes.

Typically, we do not expect any fluorescence from bloodstains on dark fabric. However, it was observed in this case. Fluorescence from bloodstains was visualized on denim when utilizing the Crime-lite® ML Blue-Green, the Crime-lite® ML Blue, and the Crime-lite® Auto Blue, and on black cotton when utilizing the Crime-lite® Auto Blue and the Crime-lite® Auto Violet. It is possible that bacteria grew on these stains and resulted in visible fluorescence. 16/47 (34%) blood-containing samples observed with the Crime-lite® Auto IR produced detectable results that were otherwise undetectable with an ALS. Although there were 5/47 (10.6%) blood-containing samples that were negative with the Crime-lite® Auto IR that were otherwise detectable with the Crime-lite® MLs, it is not typical to expect fluorescent detection with the Crime-lite® MLs anyways. Thus, I would not consider this to be an area of concern for underperformance.

For non-biologicals, the Crime-lite® Auto IR performance is improved in comparison to the Crime-lite® MLs. The number of false positives is reduced with the Crime-lite® Auto IR.

GSR was also better visualized with the Crime-lite® Auto. The best setting to use for GSR is the IR to negate the material color and pattern.

Considering these factors above, the Crime-lite® Auto IR is effective for use in the Forensic Biology and Crime Scene Reconstruction units.

Crime-lite® Auto Ultraviolet

Presently, the laboratory has no UV illumination function. Both UV light functions, overall, under-performed existing methods. In the tables above, the Crime-lite® Auto UV was compared to capabilities of the Crime-lite® MLs for consistency purposes.

68/229 (29.7%) biological samples yielded a negative result with the Crime-lite® Auto Ultraviolet arm lights when the Crime-lite® MLs could detect some intensity of fluorescence for these same samples. 47/229 (20.5%) biological samples yielded a negative result with the Crime-lite® Auto Ultraviolet lens light when the Crime-lite® MLs could detect some intensity of fluorescence for these same samples. Some of these samples are the same as above: detectable fluorescence with the Crime-lite® MLs was noted to be positive only because I knew where to look for the stain; in a real casework scenario, with no indication of where body fluids may have been deposited, this stain probably would not have been located. However, this does not account for all 68 and 47 samples respectively.

The only stains that the Crime-lite® Auto Ultraviolet lights outperformed the existing methods was in the observation of mixed biological samples. The mixed biological samples were all mixed with blood. The UV light is not a manufacturer recommended light source for the observation of blood stains. However, I chose to use the UV light feature for mixed biological samples since these stains also contained non-blood biologicals.

For non-biologicals, the Crime-lite® Auto UV arm lights had decreased performance in comparison to the existing Crime-lite® MLs. The number of false positives increased. However, the

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Crime-lite® Auto UV lens light performance is improved in comparison to the Crime-lite® MLs. The number of false positives decreased.

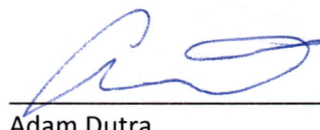
Considering that the UV lights underperformed the existing methods for all samples except mixed biologicals, if the Crime-lite® Auto Ultraviolet is to be utilized by the Forensic Biology and Crime Scene Reconstruction units, it should be done in conjunction with the Crime-lite® Auto Blue and Crime-lite® Auto IR. Using the ultraviolet illumination alone poses too big of a risk in missing true biological material.

References

1. Alternate Light Source Findings of Common Topical Products (Pollitt, E., Anderson, J., Scafide, K., ...)



Elizabeth Wade
Criminalist

 12/15/23

Adam Dutra
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