UV Photography using a 375 LED Flashlight

Although this photography is in the UV spectrum, it is a very long wavelength UV known as UV-A, and therefore will not give the full range of spectral reflective/absorptive information that is possible with a dedicated UV lens such as the Nikon 105/4.5 UV.

Recent availability of UV-A Light Emitting Diodes (LED) has stirred the interest of photography in this spectral region, although it should be noted that there are a number of challenges. First, decades of lens development have been focused on designing them to work in the visible spectrum. This is because lens performance dramatically degrades in wavelengths outside the visible range and most notably in the UV.. Correspondingly, the detectors of light have been designed for light with wavelengths longer than those in the UV

This technical note will address these areas of concerns as well as the limitations of the LED light sources. (A subsequent note will discuss Optical filters that will overcome these limitations and performance and price will be compared across these recommendations.)

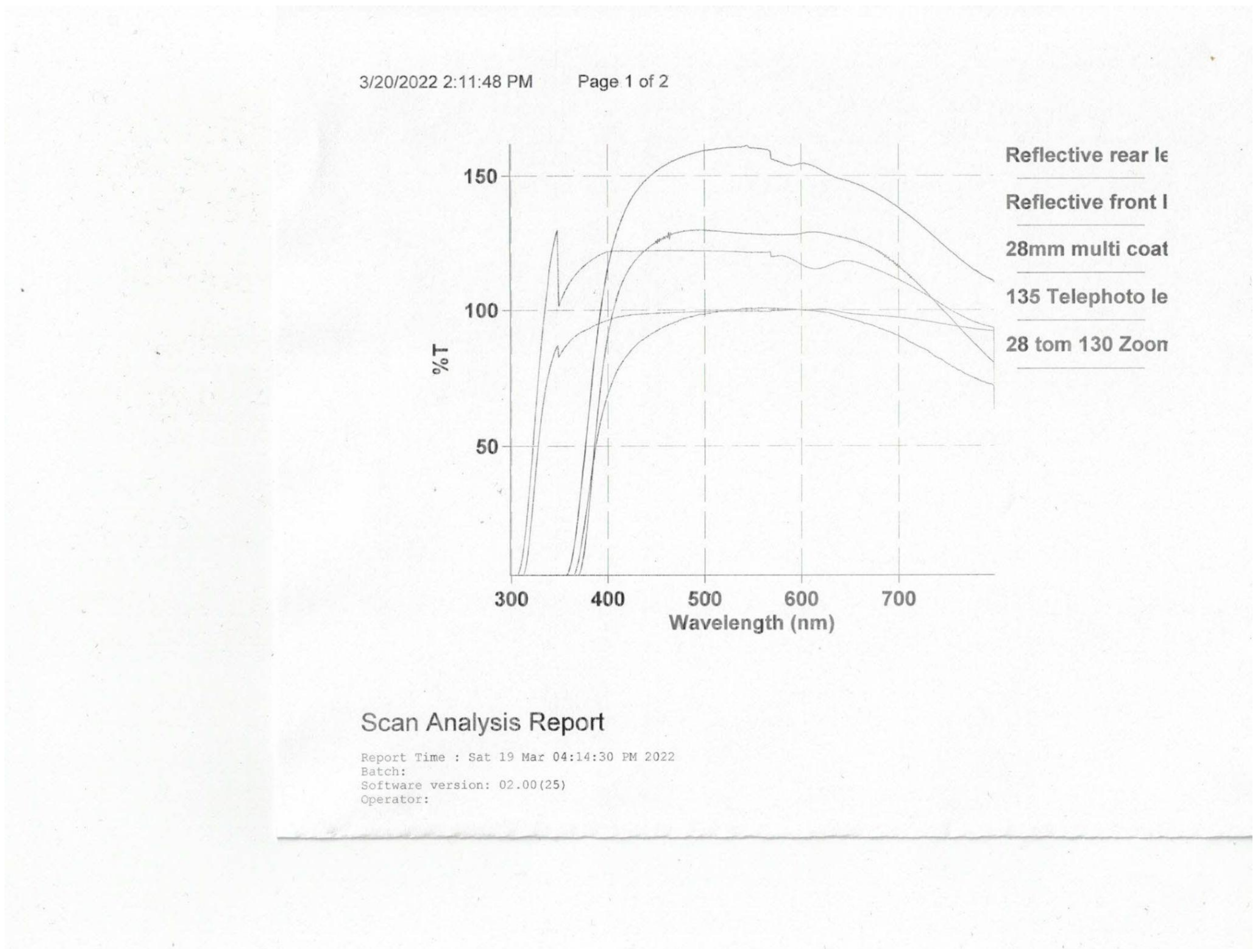
This note will start with the performance of the LEDs and then will focus on a lens system that performs quite differently at these shorter and more energetic wavelengths. Finally, we will consider the limitations of contemporary detectors of these UV wavelengths. Early detectors of light were optimally applied to short and energetic wavelengths. These detectors observed the current that passed through gas when UV light fell on the surface of a material with loosely bound electrons. Contemporary detectors are designed to respond to the much lower energy of visible and IR light. (The following white paper will discuss other potential light sources such as light from a deuterium plasma and the arc sources of Mercury and Xenon, as well as the UV in a halogen lamp.)

The Issues With Lenses

As previously mentioned the concepts of photography and modern lenses do not go together for taking an image in the UV. Three distinct aspects of lens design come into play. The first is that the lens is designed to bring an image of visible light to a common focal plane, which is not consistent with where the focal plane will occur for shorter wavelength UV light. The second and third aspects have to do with the materials used to make the lens, which are not optimized for the UV region.

Typically in lens design, there is a need for a component at an elevated value of refractive index and dispersion. This element will have an absorption edge occurring close to the visible range, and so impact the transmission of the UV energy. Even more of an issue is that the coating of the lens elements used to reduce Fresnel reflection occurring at the various air to glass surfaces is achieved by using a material (typically TiO_2 or Nb_2O_5, or similar) which has a sharp absorption starting at 420 nm. Without these coatings, many lens materials would have poor transmission and a high degree of scatter in the visible. Although these lens limitations preclude a true UV image, the majority of lenses used with typical cameras match quite well with the output of a “UV Flashlight or a UV Sterilizing light box. I am including spectral data of these two elements.

See Fig. 3 (An assortment of transmission plots of complex multi-coated lenses typical of contemporary cameras.)



Except for a few lenses specifically manufactured for UV imaging, the best lens will be one with the fewest elements. A folded reflective lens such as a Rokor 500 mm would be ideal for any mid UV in the region of 320 to 400 nm.

The Issues With The LED sources

The UV Torches,Flashlights, Sterilization Lamps, and Forensic flashlights that list outputs of 365 or 375 nm, are typically emitting wavelengths significantly longer than those listed . Furthermore, although they have prominent emission in the UV, there is a long tail in the distribution to longer wavelengths. Additionally, there are secondary prominence, namely at 540 and 780 nm. These secondary emissions flood UV emission and make any image only blue enhanced.

Fig. 1 shows the output of a UV sterilization lamp with an overlay at a 20X.

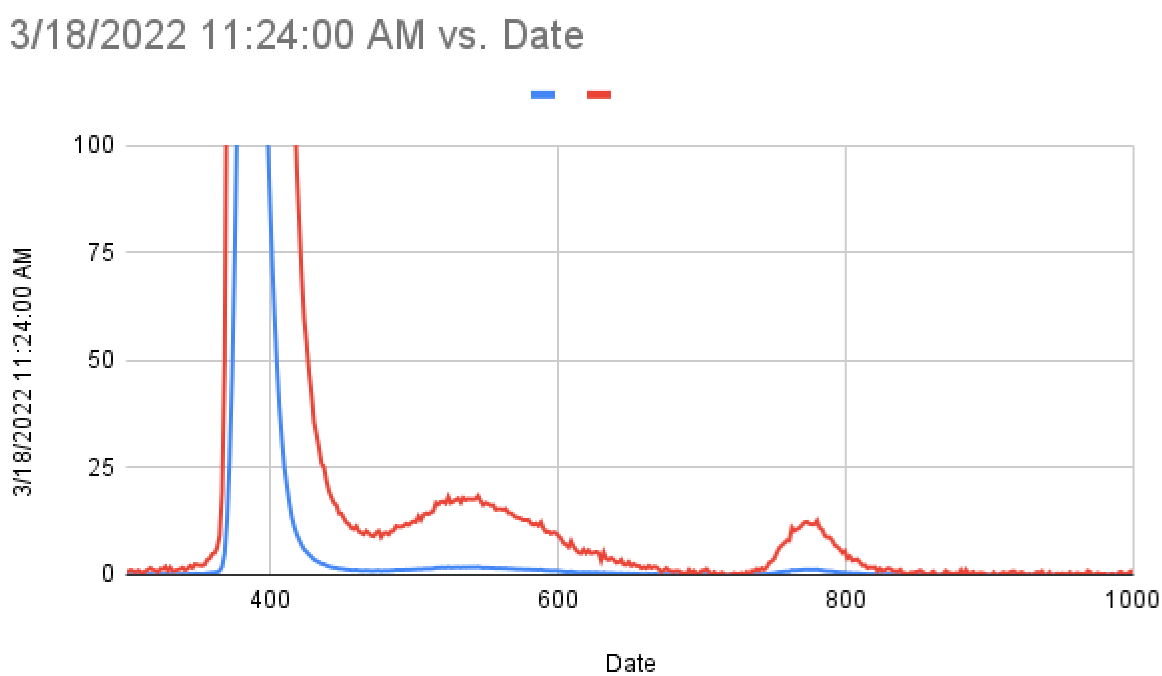


Fig. 2 shows the output of a Forensic Flashlight with an overlay at 20X.

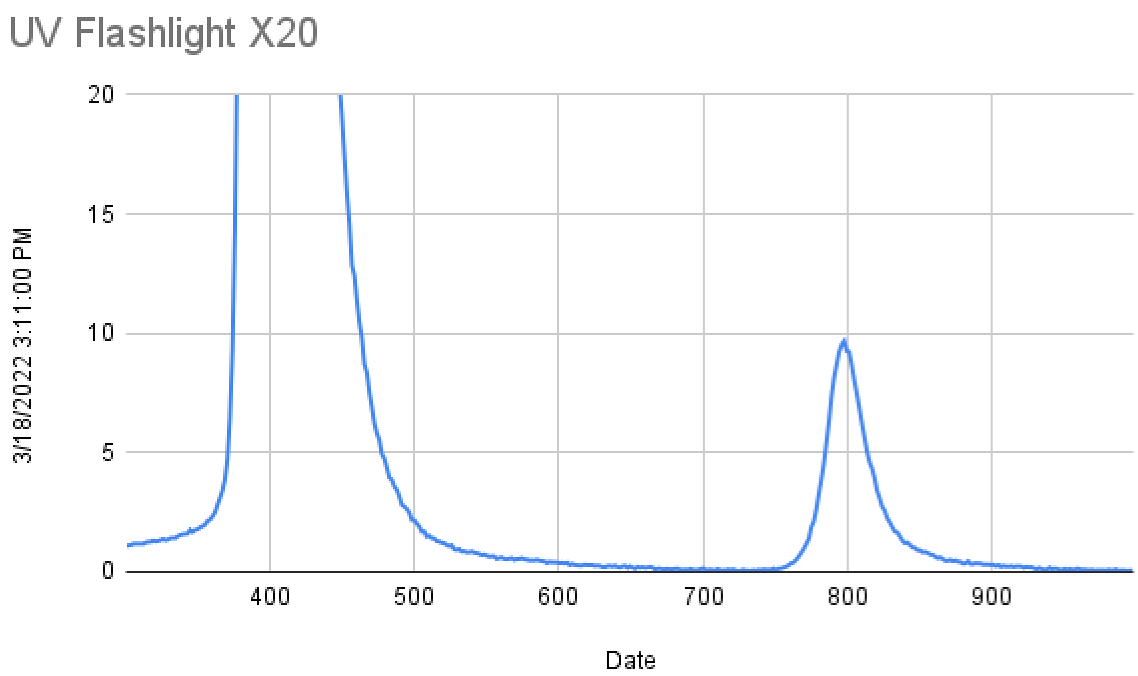
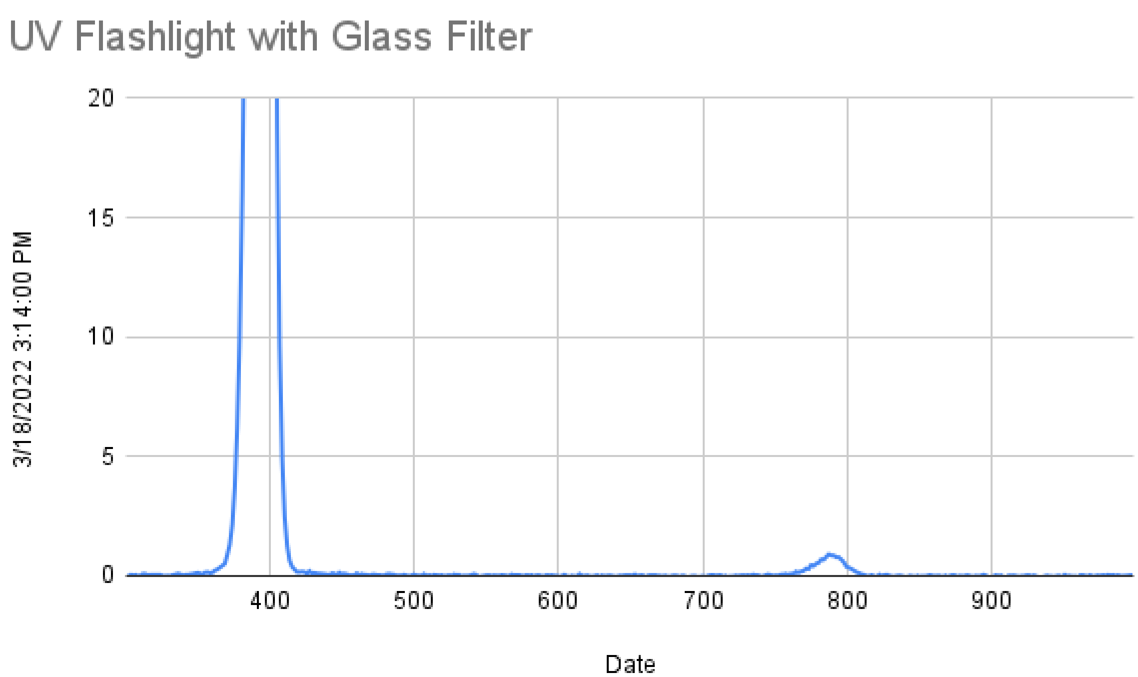


Fig. 3 shows the Forensic Flashlight with RSS UV Clean-Up filter



In conclusion, the requirements for UV photography are not trivial. An introduction to UV photography can be realized with a lens, ideally of the fewest elements, and the longest focal length. A common camera lens in conjunction with a 375 UV LED source such as a forensic flashlight or UV sterilization lamp, will give an image of the UV-A in the region of 380 to 400 nm. To eliminate the visible pollution from these light sources, one will need an RSS UV Clean Up filter, available in a number of standard ring sizes.

Without having to buy a $5000 plus lens such as the UV-Nikon 105/4.5, an intermediate solution for mid UV would be a Mirror Lens such as Opteka 500mm F/8 Macro. This lens is suitable for the region from 320 to 400 nm (referred to as the UVA and B regions).

In a future note we will discuss other light sources for the entire UV spectral region. Unfortunately, there are few light sources that have reasonable output at these shorter wavelengths.