

# -- Ultraviolet against a Second Wave --

*Ultraviolet: definition, use and innovation*

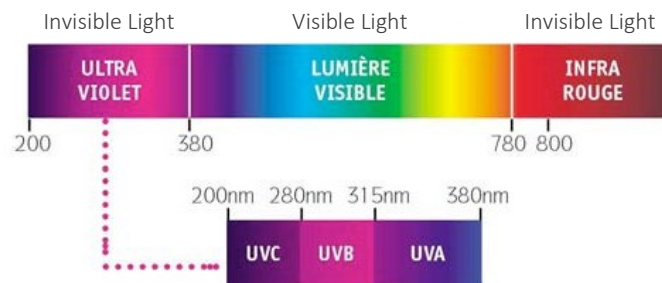
The purpose of this article is to clarify your understanding of how photonics and more specifically Ultraviolet (UV) can help us master a possible second post-deconfinement wave. We find a lot of articles, products and information appearing on this subject with more or less seriousness and we wanted to help you keep a critical mind towards this flow of data.

The examples will mainly be based on SARS CoV-2 more commonly known as Covid-19, which is currently the center of attention, but they will also help us to understand the facts for other pathogens such as viruses, bacteria, fungi and algae.

## UV, What is this?

The wavelength (expressed in nm for nano-meter) characterizes the type of light (it's colour for example), our eye is sensitive to the range from 400nm to 700nm which represents 'visible light', it goes from purple to red. A Rainbow is a perfect example of the color palette that our eye is able to see.

UV light is between 200nm and 400nm and is normally divided into three categories: UVA (400 - 315 nm), UVB (315 - 280 nm), UVC (280 - 200 nm).



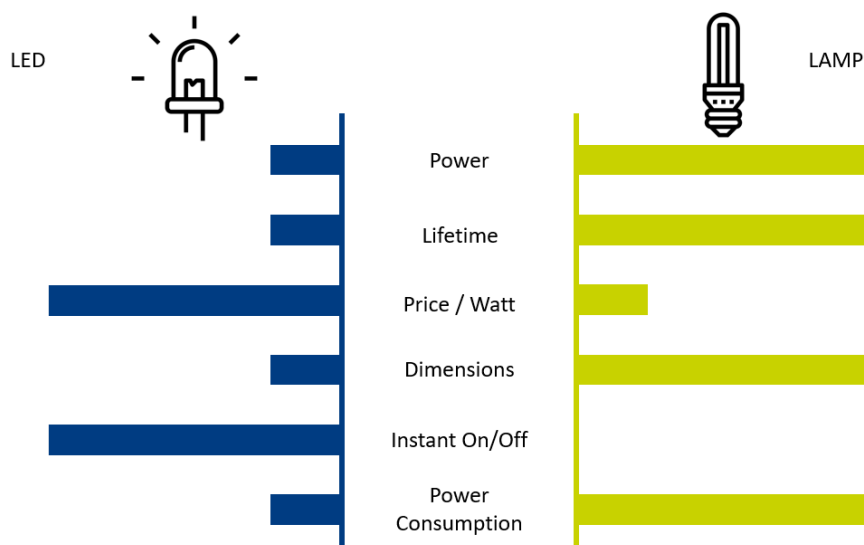
The sun produces all three categories of UV. However, the ozone layer in the atmosphere absorbs the vast majority of UVB and UVC rays. At ground level there is almost only UVA left.

UV-C is harmful. Living beings are not naturally exposed to this wavelength of light, because most of it is absorbed by our atmosphere and its ozone layer, so have never developed systems to protect themselves from it.

UV rays are known to be harmful to the skin and eyes, which is why we protect ourselves by putting on sunscreen and wearing sunglasses. In reality UV is harmful to all living things, from microorganisms (viruses) to humans.

## What are the sources of UV?

Besides our sun, many sources of artificial UV exist: the three main types are lasers, lamps, and LEDs. In our article we will focus on the last two, lasers typically have a point source and therefore are not suitable for decontaminating surfaces. In general, the main differences between LEDs and lamps in the UVC are summarized below:



In UVC the interest of LEDs will be limited to making small compact systems, where the lamps are too bulky. The lamps are more powerful, last longer and are cheaper. This is why for the vast majority of applications where UVC is required, lamps are preferred.

But with equivalent spectrum (UVC for example) all UV lamps are not equal and to know if a lamp is going to be effective two important parameters must be taken into consideration.

**Power:** Often expressed in  $\text{mW} / \text{cm}^2$ , it quantifies the intensity of light emitted during 1 second. Or is 'how bright the light is'.

**Quantity:** If an object moves under a lamp, the slower it goes or the higher the power the greater the exposure to UV Light.

It is this quantity of light received, called the "dose" that allows us to compare different solutions. It is expressed in  $\text{mJ} / \text{cm}^2$  (J = Joules) and we calculate it as follows:

$$D_{\text{dose}} = P_{\text{power per unit area}} (\text{mW}/\text{cm}^2) \times E_{\text{exposure time}}$$



## UV against microorganisms

At the end of the 19th century, it was discovered that UV light deactivated micro-organisms and that the most effective wavelength is in UVC around 254 nm. UVC interferes with and destroys the nucleic acids, DNA or RNA of bacteria, viruses or other micro-organisms. The micro-organisms can no longer reproduce and become inactive.

Over the next century many applications developed, the main and best known being the decontamination of drinking water. In 2006 the ANSES (National Agency for Health, Environment and Work Safety) recalls reported the effectiveness of this technology (1).

## What about the UV facing Covid-19?

UVC has been used in the past to fight other coronaviruses like MERS and SARS and was used in the fight against the recent Ebola outbreak in West Africa. Furthermore it is expected to have the same effect on Covid 19. This is why UV light and in particular UVC is taking an increasingly important role in the fight against the Covid-19 alongside, social distancing, hand sanitizer gel and different PPE. ... UV appears to be a quick fix to destroy the virus everywhere: on your mobile phone, in the air, in your water bottle, on your hands ...without using chemicals that can damage electronics.

**But** there are several points to be aware of:

UVC is very effective against micro-organisms, but is also dangerous for humans, we are also an organism. UVC lamps should not be used if there is any exposed skin! The International Association of Ultraviolet (<http://www.iuva.org/>), in a press release of April 24, 2020, strongly advises against its use on the human body. The WHO (World Health Organization) is even organizing an awareness campaign against the use of UV lamps to sterilize hands or skin.

Numerous offers for UV lamps to sterilize air, objects and surfaces are flourishing on the Internet. As discussed above, the majority of these solutions can be dangerous and do not reach the required UVC dose in the time suggested, so not deactivating the virus!

### Covid-19 lifespan

A study of April 16, 2020 [4] published by the New England Journal of Medicine investigates the viability of Covid-19 in air and on various surfaces, established that the virus would be stable up to 72 hours on surfaces and 3 hours in the air.

This study also indicated that aerosol (air) transmission of Covid-19 is possible, as it remains active for several hours in air.

UV therefore is a solution for decontaminating both surfaces and air.

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Covid-19 is active for up to 72 hours on certain surfaces and 3 hours in the air.

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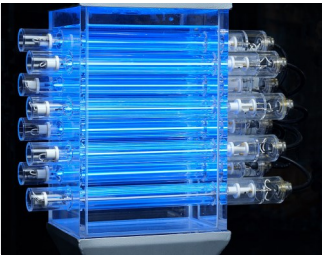
### UV dose required

The dose required to deactivate different viruses and bacteria in water is very well known and is noted in a 2005 review [2]. Note that the dose will deactivate a certain percentage of virus, more dose by increasing the dwell time, means a higher percentage of deactivation.

- However, there have been no published studies specifically carried out on the Covid-19 virus, but some elements can be used to estimate the necessary dose:
- Covid-19 contains single-stranded RNA and studies have shown that viruses with single-stranded RNA are 6 times more sensitive to UV than those with double-stranded RNA.
- Covid-19 has a diameter of 0.05-0.2 micrometers and a virus of 0.1 micrometers in diameter, it takes 10 mJ / cm<sup>2</sup> to deactivate it [3].
- A coronavirus requires 6mJ / cm<sup>2</sup> in air with low humidity to be 90% deactivated [3].

# Applications Facing Covid-19

## Water Decontamination



On September 8, 2017, an international convention was signed by nearly fifty-two countries which requires fleets of ships to clean their ballast water. This operation is carried out using UV treatment stations.

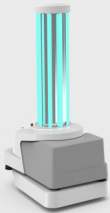
Image : <https://www.eta-uv.com/en/applications/environmental-technology>

The world's largest drinking water treatment facility is located in New York City, decontaminating 7.6 billion liters of water per day with a reduction of 99.9%, using UVC.

Image : <https://www.resources.trojanuv.com/uv-disinfection-new-york-city-drinking-water-facilities/>



## Surface decontamination



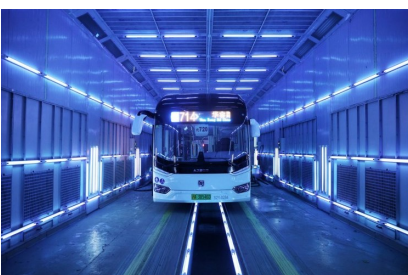
UV robots are playing an increasingly important role in the face of the Covid-19 crisis. The Chinese government recently ordered 2,000 UV robots to decontaminate its hospitals, trains and subways. A few days ago, Nice Airport also equipped itself with this type of device.

Image : [https://www.hospitalia.fr/Des-robots-pour-lutter-contre-les-maladies\\_a2145.html](https://www.hospitalia.fr/Des-robots-pour-lutter-contre-les-maladies_a2145.html)

Many emergency services are equipped with portable devices in order to be able to quickly decontaminate the surfaces between two interventions.

Marseille firefighters have also recently equipped themselves with around twenty UV lamps to intervene in highly contaminated areas.

Image : <https://www.integrationtechnology.com/en/contact/>



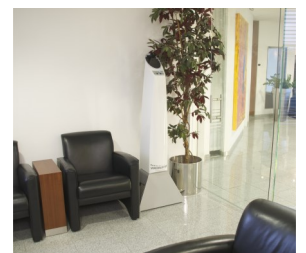
The Shanghai public transport company has converted a washing station by integrating 120 UV lamps to disinfect its buses. This new process allows them to reduce the decontamination time from 40 minutes to 5 minutes.

Image : [http://french.china.org.cn/travel/txt/2020-03/05/content\\_75777884.htm](http://french.china.org.cn/travel/txt/2020-03/05/content_75777884.htm)

## Air decontamination

Busy places are equipped with devices to quickly and effectively decontaminate the air. Ideal for open spaces, restaurants, hotels, these air decontamination devices allow the recovery and destruction of possibly contaminated aerosols.

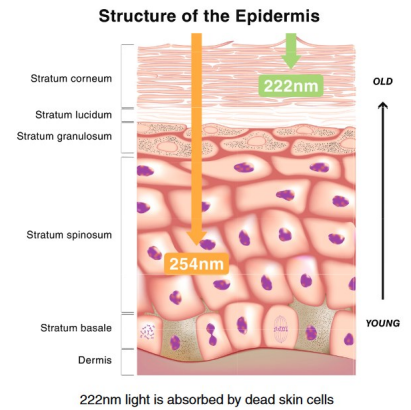
Image : <https://www.ist-uv.fr/fr/applications/sterilisation/disinfection/sterilisation-de-lair>



## An innovation, the distant 222nm UV

A solution for using UV in human presence could come from "far" UV. This wavelength even shorter than UVC 254 nm and seems to be harmless to humans, but just as effective against microorganisms. This technology was first studied to deal with influenza. Many researchers and companies have taken up the subject since the appearance of Covid-19 and there are studies currently underway to validate its efficacy and the first results seem quite promising.

Most public places like hospitals, trains, shopping centers, planes may be equipped with this new technology in the future.



## In conclusion

This article may seem a bit technical, but it is quite fundamental as it allows you to understand what UV is all about. It makes it possible to better understand the interest that UVC can have vis-à-vis the Covid-19 and in particular its benefits in addition to social distancing, hand sanitizing gel and different PPE to prevent and control a potential second wave.

However, you must remain vigilant about the use of UV and therefore to use validated systems whose effectiveness can be proven!

Depending on what you want to decontaminate, at what speed and for a given reduction it is necessary to be advised by professionals who understand the subject of UV decontamination.

Determining your UV Sanitization solution can be straightforward with the right partner!

### Sources :

- [1] ANSES, Novembre 2010. Évaluation de l'innocuité des réacteurs équipés de lampes à rayonnements ultraviolets et de l'efficacité de ces procédés pour la désinfection des eaux destinées à la consommation humaine
- [2] Hijnen, Wim & Beerendonk, Erwin & Medema, Gertjan. (2006). Inactivation Credit of UV Radiation for Viruses, Bacteria and Protozoan (oo) Cysts in Water: A Review. Water research. 40. 3-22. 10.1016/j.watres.2005.10.030.
- [3] W. Kowalski, Ultraviolet Germicidal Irradiation Handbook. Springer Berlin Heidelberg, 2009.
- [4] N. van Doremalen et al., "Aerosol and Surface Stability of SARS-CoV-2 as Compared with SARS-CoV-1," New England Journal of Medicine, Mar. 2020.