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Safe and automatic disinfection technology

Lead Scientist Camilla Höglund
LED Tailor

Agenda

- Why choose Spectral Blue®?
- Success-stories
- Hella marine & LED Tailor partnering
- Science; How and why is works
- Summary

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by

LED TAILOR®

OFF **BLUE** **WHITE**

Spectral Blue® disinfection technology in a nutshell

- Patent-pending **Multi-Wavelength, High-Intensity** (MWHI) blue LED light technology developed by LED Tailor
- **Kills pathogens in the air and on surfaces continuously** - active whenever room is unoccupied
- **100% safe for people and materials:** Touch-free, chemical-free & UV-free
- Automatic switching between regular white light and blue light
- Optional photocatalytic coating for surfaces

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Why choose Spectral Blue® to prevent epidemics and stay safe?

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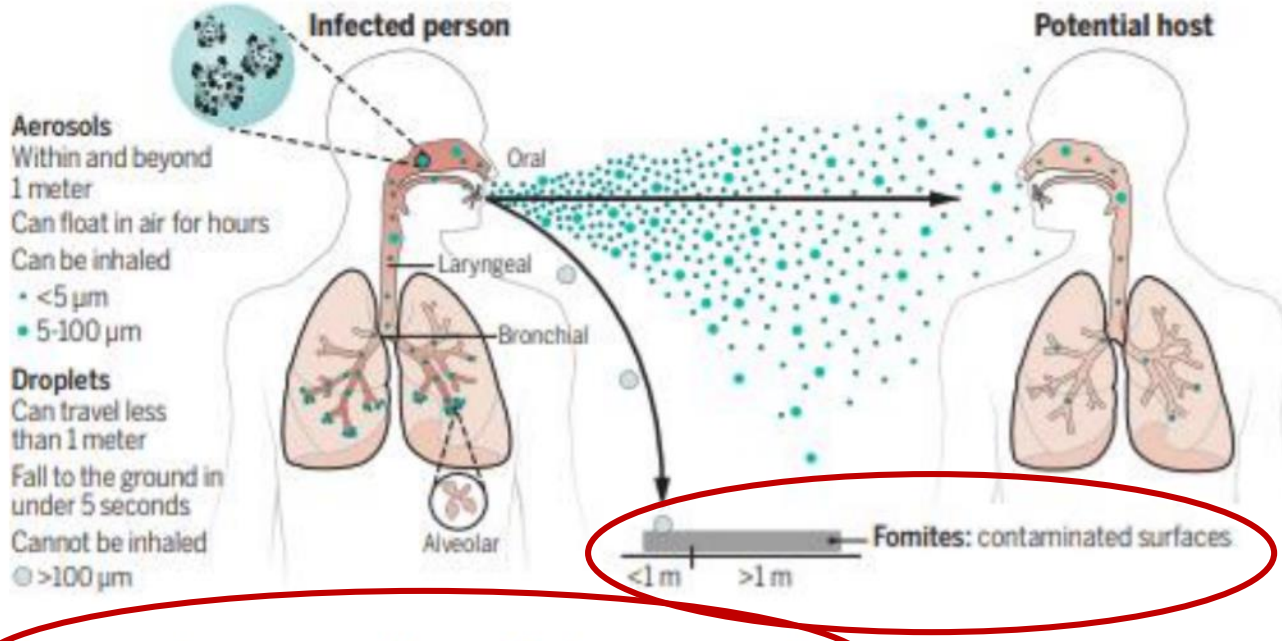
Simply focusing indoor air solution is not sufficient

Lähde: Tytti Vuorisen esitys 10.9.2021 ”Hengitystievirusten leviäminen”



- Suuret pisarat < 100 µm laskeutuvat alas

Larger droplets will fall onto the surfaces quickly.

From there, they can infect a person via direct contact or re-dispersion into the air (like dust).

For example Norovirus is usually spread via contaminated surfaces or direct contact with a contaminated person.

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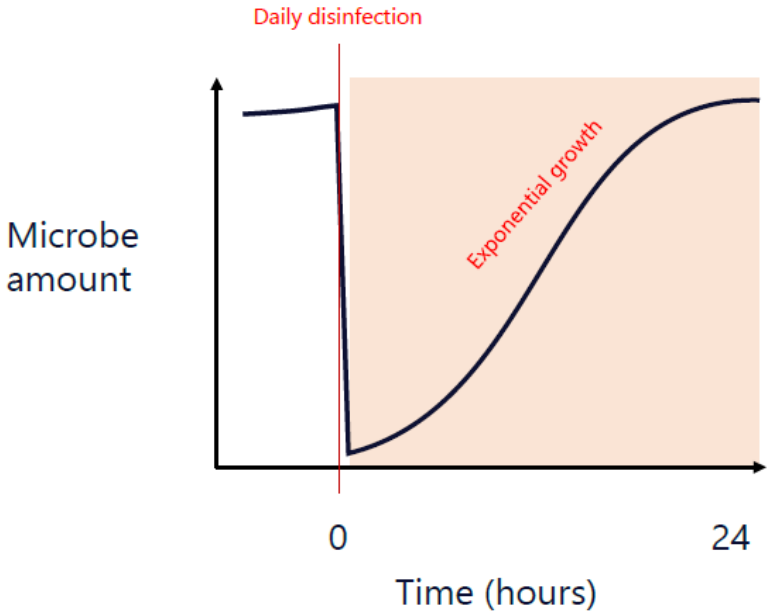
Disinfects both air & surfaces continuously
– it keeps your ship safe 24/7, not just a short period of time every day

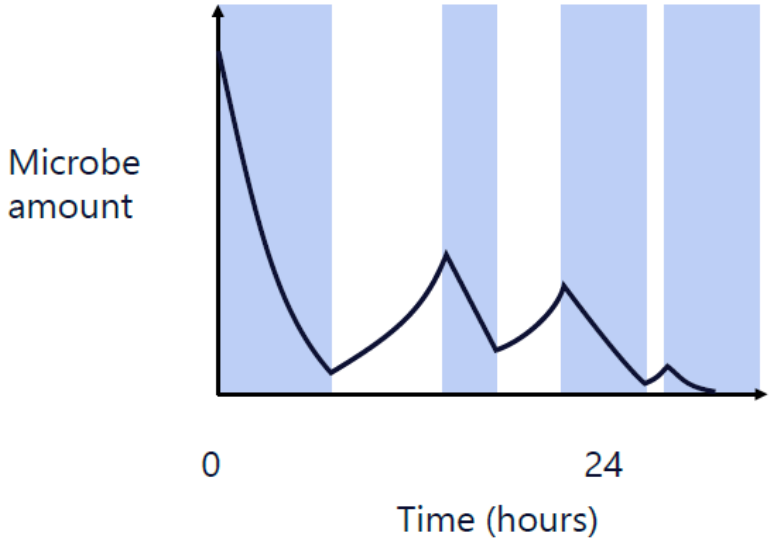
Traditional disinfection & recontamination:



Will only keep microbial levels low for a short period of time.

- microbe amounts will start to grow as soon as people use the room again. The recontamination happens fast especially in restrooms, where diseases spread easily.

Continuous Spectral Blue® disinfection:



Will continuously suppress microbe growth and maintain a high hygienic level around the clock

- ensuring that your ship is always a safe place and infections cannot spread.

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Spectral Blue® reference – a longitudinal real-world test over 3 years:

Massive reduction in staff's sickness absence after installing blue light disinfection in toilet/bathroom

6 SALON SEUDUN SANOMAT | LAUANTAINA 13. MARRASKUUTA 2021

UUTISET Vinkkaa uutinen: (02) 770 2314 | toimitus@sss.fi

Sininen valo vähensi päiväkodin sairauspoissaoloja

Aurinkoleijonan henkilökunnan sairastelu jäi kolmannekseen entisestä.

SSS | Minna Filppu
minna.filppu@sss.fi

Montessoripäiväkoti Aurinkoleijonan Salon yksikön sairauspoissaolot vähenivät merkittävästi sen jälkeen, kun päiväkodin wc- ja pesuhuoneissa oli otettu käyttöön siniseen valoon perustuva automaattinen desinfiointijärjestelmä. Salolaisen LED Tailorin innovaatio vähensi työpaikan sairauspoissaoloja kahdessa vuodessa peräti 70 prosenttia.

– Henkilökunnan sairauspoissaolot olivat Salon yksikössä enää vain kolmanneksen Halikon yksikön verrattuna. Lasten sairastaminen ei ole vähentynyt yhtä rajusti, mutta huomattavasti sekin, Aurinkoleijonan johtaja **Päivi Isopuro** toteaa.

Hän innostui hankkimaan sinivaloteknologian Salon yksikköönsä vuonna 2018 saatuaan siitä tietoa yrittäjäyhdistyksen tilaisuudessa.

– Yksityisen päiväkodin yrittäjänä halusin olla edelläkävijä. Erityisen hienoa oli, että teknologia on paikallista, Isopuro korostaa.

– Ratkaisun taustalla oli myös painetta siitä, että hoitolasten vanhemmat haluavat käydä töissä, eivätkä olla poissa lastensa sairastamisen takia.

SSS / JUKKA VASO

Aurinkoleijonan johtaja Päivi Isopuro on tyytyväinen tehonsa osoittaneeseen siniseen valoon perustuvaan desinfiointijärjestelmään. – Säästöä tulee sitä enemmän, mitä vähemmän väki sairastaa.

"Tänä vuonna esimerkiksi vatsatautia ei ole ollut ollenkaan ja räkätautejakin todella vähän."

Aurinkoleijonan johtaja Päivi Isopuro

Näkyvä sininen valo tuhoaa mikrobit ilmasta ja pinnoilta.

Tavallisilta valaisimilta näyttävät desinfiointilaitteet voidaan asentaa kiinteästi kattoon tai käyttää pyörillä liikuteltavia laitteita.

Päivi Isopuro varautui seuraamaan uuden teknologian vaikutuksia parin vuoden ajan.

– Ensin työntekijät huomasivat, että Halikossa on enemmän sairauspoissaoloja kuin Salon yksikössä, ja samaa todisti myös Excel-taulukkoni, kertoo Isopuro, joka asennutti sinivaloteknologian tänä vuonna myös Halikon yksikköön.

– Desinfiointirattaisut ovat nousseet entistä suurempaan rooliin koronan takia, hän huomauttaa.

Aurinkoleijona työllistää kaikkiaan 18 ihmistä Salossa ja Halikossa.

– Tartuntataudit ovat vähentyneet meillä selvästi. Tänä vuonna esimerkiksi vatsatautia ei ole ollut ollenkaan ja räkätautejakin todella vähän, Päivi Isopuro iloitsee.

– Se on selvää, että uuden työntekijän aloitettua työnsä päiväkodissa, hän sairastaa vähintään yhden tartuntataudin, sillä vastustuskyky pitää ensin hankkia.

Isopuro toteaa sinivaloteknologian hankinnan olevan kertainvestointina kallis, mutta esimerkiksi Aurinkoleijonassa se maksaa itsensä takaisin vuodessa–puolessatoista vähentäessään sairauspoissaoloja.

– Säästöä tulee sitä enemmän, mitä vähemmän väki sairastaa.

Isopuro toteaa, että tehokas desinfiointijärjestelmä on korona-aikana luonut myös turvallisuuden tunnetta.

– Meillä ei ole ollut yhtään koronatapausta eikä edes altistumista, hän painottaa.

LED Tailor on kehittänyt Spectral Blue -sinivaloteknologiaa vuodesta 2016. Sininen valo alkaa yhä useammissa paikoissa korvata perinteisiä desinfiointitapoja. Sitä on käytössä muun muassa sairaaloissa, ambulansseissa, toimistoissa ja julkisissa tiloissa niin Suomessa kuin ulkomailla.

Desinfiointijärjestelmä tehoaa kaikkiin mikrobeihin, kuten koronaviruksiin, influenssaviruksiin ja vastustuskykyisiin bakteereihin, ja vähentää siten tartuntoja. Sininen valo toimii jatkuvasti ja pitää tilat turvallisina ympäri vuorokauden. Patentoitu menetelmä on turvallinen käyttäjille, tiloille ja ympäristölle.

This customer manages two kindergardens in Salo, one located in the city centre, one a few km outside. Some of the staff is partly working on both locations. Sick-leave is calculated as total sick-days among staff / amount of children at location.

Comparison is made between location in city centre that installed blue light in their toilet/restrooms in spring 2018, compared to the kindergarden that did not. Cleaning routines have been kept stationary during this time.

Results:

Year 2018-2019 (August-June):
70% less sick-leave

Year 2019-2020 (August-June):
68% less sick-leave

Year 2019-2020 (August-June):
43% less sick-leave (generally longer due to corona)

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Case study (USA):

Installing blue light reduced surgical infections by 75%

(using a much less efficient blue light system compared to Spectral Blue®)

Operating room with Blue light

75%

Reduction in SSI

(from 11 cases to 3)

Control: Operating room without blue light

No reduction

- **The hospital tracked SSI statistics from orthopedic operating rooms 1 year prior and 1 year after installing blue lights in one OR.**
- **The operations in each OR were primary joint arthroplasties (total knee, total hip, shoulder, and ankle).**
- **Hospital's standard cleaning and disinfection protocols were performed as usual.**

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Influence of a visible-light continuous environmental disinfection system on microbial contamination and surgical site infections in an orthopedic operating room,
American Journal of Infection Control, Volume 47, Issue 7, July 2019, Pages 804-810

Halton

PROFILE
The Original
PROFILE VEHICLES LTD.

Trusted and used by these partners
Tested by 3rd party laboratories

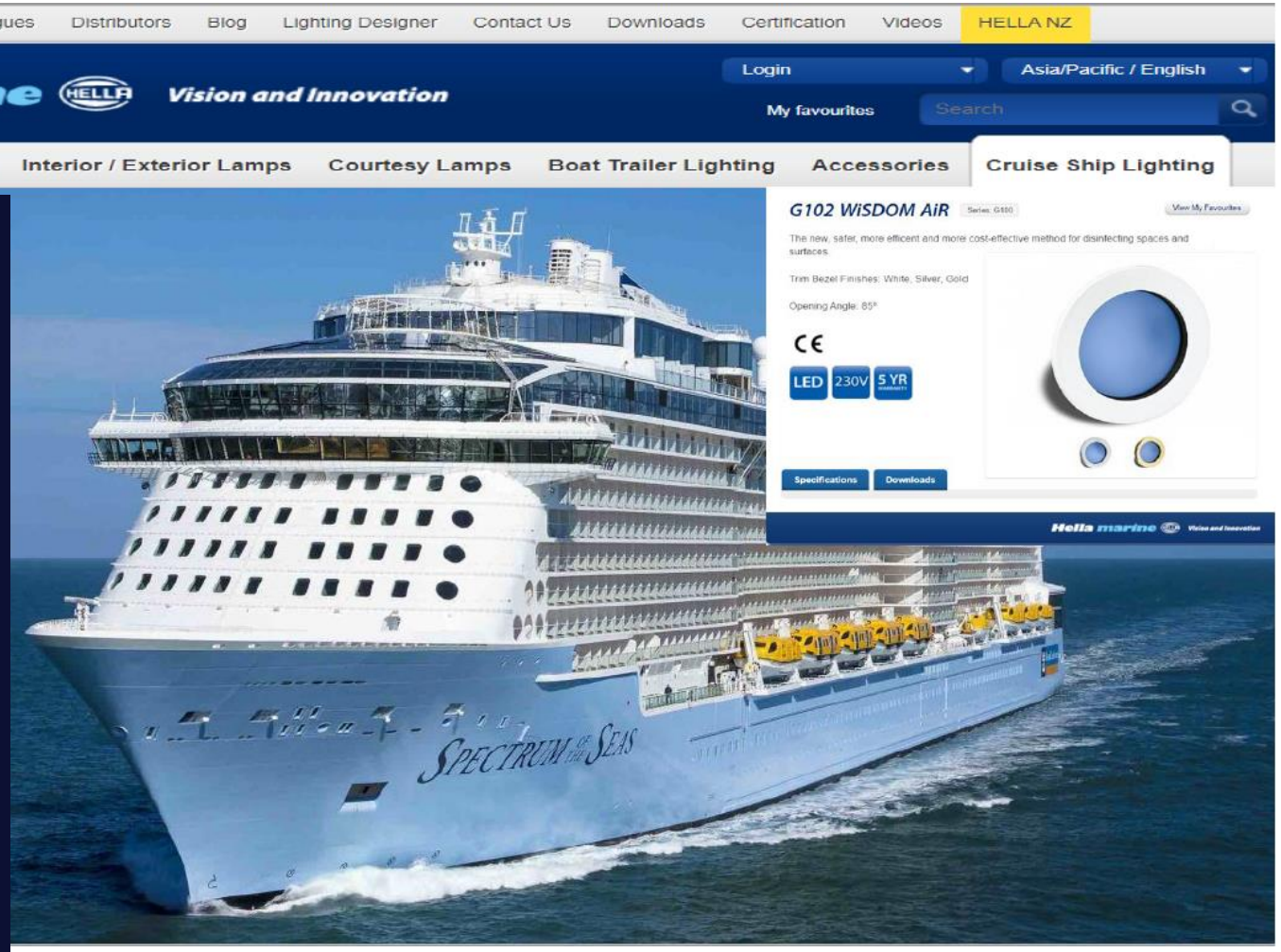
ThermoFisher
SCIENTIFIC

Hospitals: HUS, TYKS, Nova Hospital, Mikkeli Central Hospital etc

Hella Marine & LED Tailor cooperate to bring this award-winning solution to the marine industry.

RCCL "Spectrum of the Seas" (pictured) and Wasalines "Aurora Botnia" have already been equipped with **Spectral Blue® technology.**

- "Spectrum of the Seas" uses the technology in the VIP casino for air-purification purposes to reduce cigarette smoke and odors.
- "Aurora Botnia" uses it in their public bathrooms to prevent spreading of diseases onboard.



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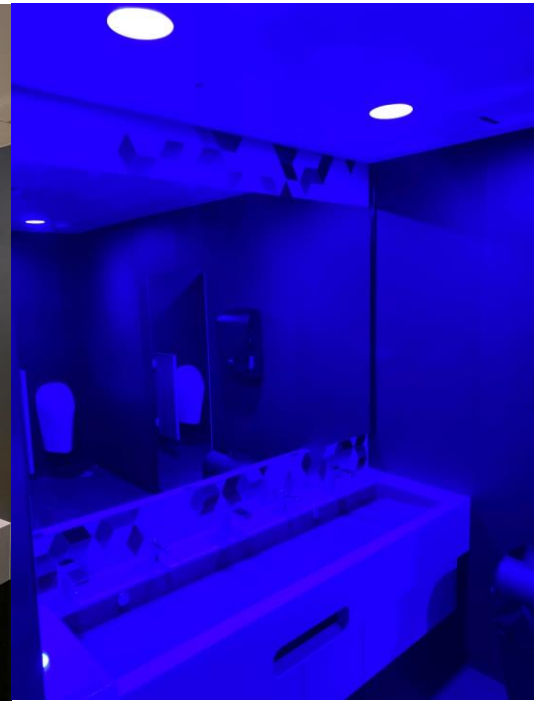
Aurora Botnia: Wasalines ferry with automatically disinfecting restrooms

For infection safety, its public restrooms are equipped with blue light emitting Spectral Blue disinfection devices.

Unlike UV-light or chemicals, this is **100% safe for people and interior materials and maintenance-free.**

The devices in the restrooms are **Hella Marine G102 WA.**

A smart DALI system is used for controlling the lights: they switch to blue when the room is unoccupied and back to general white light when people enter.



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Science

- How and why

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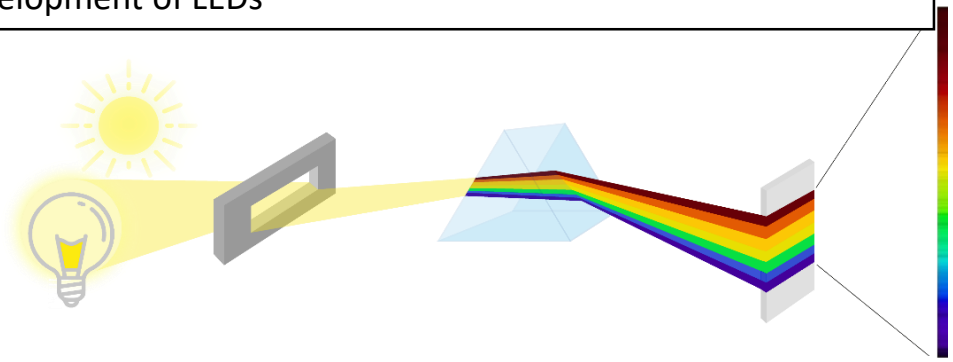
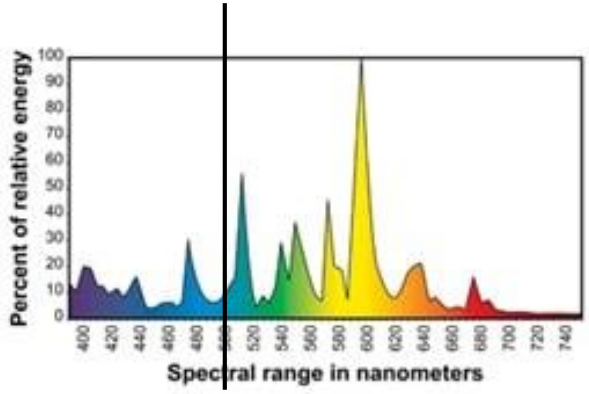
Why hasn't this technology been used before?

Answer: Before LED technology it was not possible to study the effects of specific blue wavelengths or to create efficient disinfection products.

Traditional gas-discharge lamps were used in research until the development of LEDs

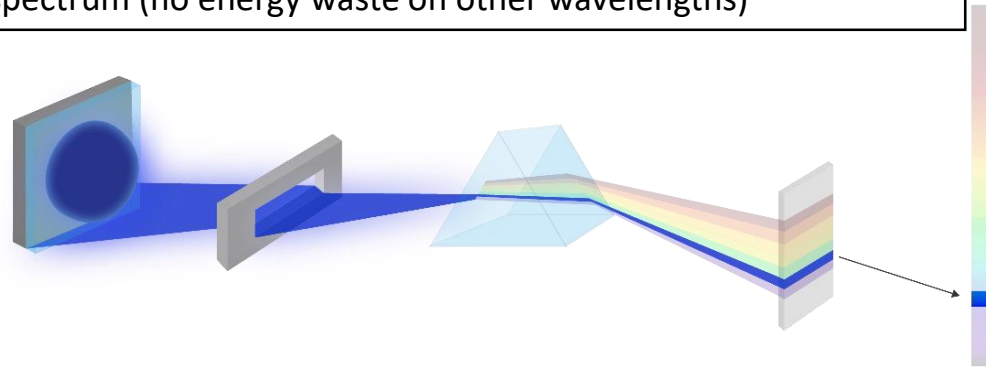


Light spectrum produced by a gas-discharge lamp

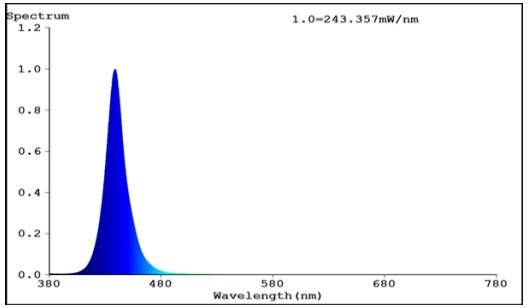


To study blue light, a filter was attached to remove unwanted wavelenghts (green, yellow, red). This resulted on huge loss of total light energy (intensity) and it wasn't possible to study different blue wavelengths and compare their individual effects. What is left is the whole blue spectra ~ 400-500nm

LEDs have the ability to produce a specific, narrow light spectrum (no energy waste on other wavelengths)



Light spectrum produced by LED



LEDs produce specific blue wavelegths very energy-efficiently and it is possible to reach higher blue light intensities, which is crucial for disinfection.
Also LEDs produce a narrow blue light spectrum, and we can use only the wavelengths that acutally kills microbes.

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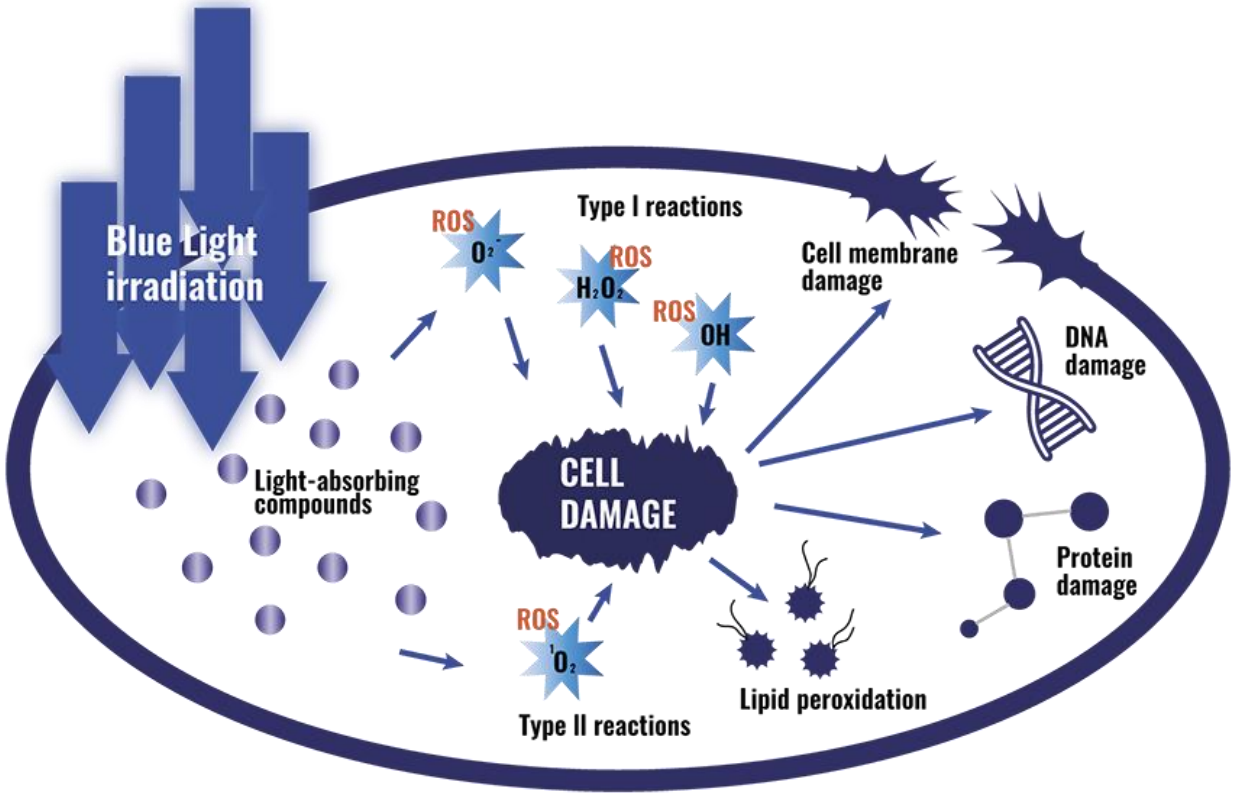
How blue light works



SAFE FOR PEOPLE:
No photobiological hazard for human eye
(EN 62471 / RG1)

HARMLESS TO MATERIALS:
Non-ionizing
(Radiation and nuclear safety authority of Finland)

Over 2000 scientific researches published on antimicrobial properties of blue light

The ability of blue light to destroy microbes is based on its ability to energize naturally light-sensitive compounds inside the micro-organism, so that they start producing reactive oxygen radicals. Reactive oxygen species (ROS) are molecules containing a very reactive oxygen, causing the bacteria to damage and destroy internally.

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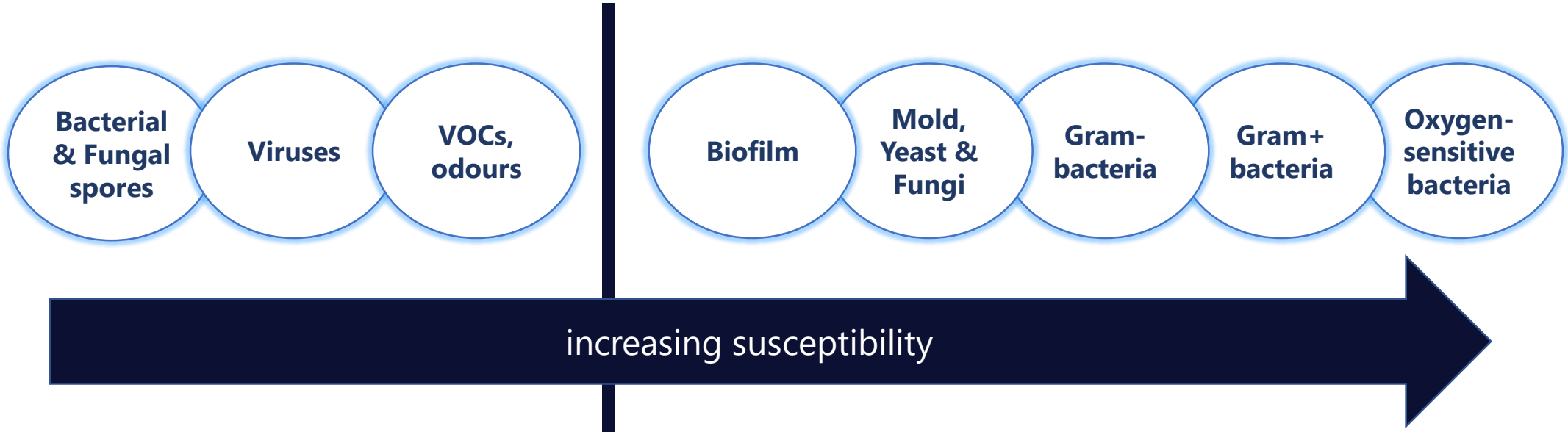
Coating extends the effectiveness

(Life-time for coating ~2-5 years, can be reapplied easily)



Blue light + Catalytic coating
combined is effective on all micro-organisms, including viruses and spores.

Reaction also destroys odours and VOC's from the air.

Blue light alone
is effective on all bacteria, fungi, mold and yeast.

Blue light also penetrates biofilm.

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Multi-wavelength blue light shown to be most effective*

- Spectral Blue® uses two antimicrobial wavelengths (patent-pending MWHI technology) and is the world's most powerful blue light system:
  - ➢ Kills all bacteria, even those that are difficult to kill with just 405 nm.
  - ➢ Kills pathogens faster* and with less energy than competitors using just 405 nm.

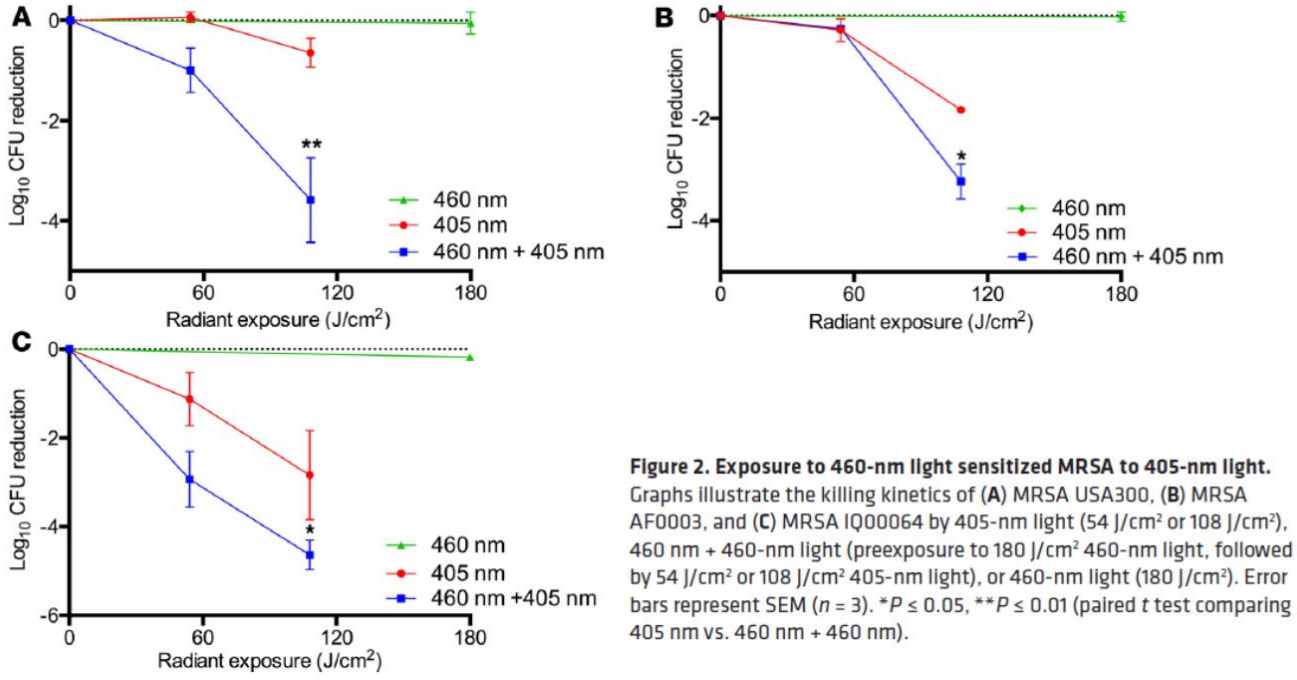

Figure 2. Exposure to 460-nm light sensitized MRSA to 405-nm light. Graphs illustrate the killing kinetics of (**A**) MRSA USA300, (**B**) MRSA AF0003, and (**C**) MRSA IQ00064 by 405-nm light (54 J/cm² or 108 J/cm²), 460 nm + 460-nm light (preexposure to 180 J/cm² 460-nm light, followed by 54 J/cm² or 108 J/cm² 405-nm light), or 460-nm light (180 J/cm²). Error bars represent SEM (n = 3). *$P \le 0.05$, **$P \le 0.01$ (paired t test comparing 405 nm vs. 460 nm + 460 nm).

***Reference by Harvard Medical School, Massachusets Universital Hospital and Boston Univeristy:**

Leanse LG, Goh XS, Cheng JX, Hooper DC, Dai T. **Dual-wavelength photo-killing of methicillin-resistant Staphylococcus aureus.** JCI Insight. 2020 Jun 4;5(11):e134343. doi: 10.1172/jci.insight.134343. PMID: 32493838; PMCID: PMC7308062.

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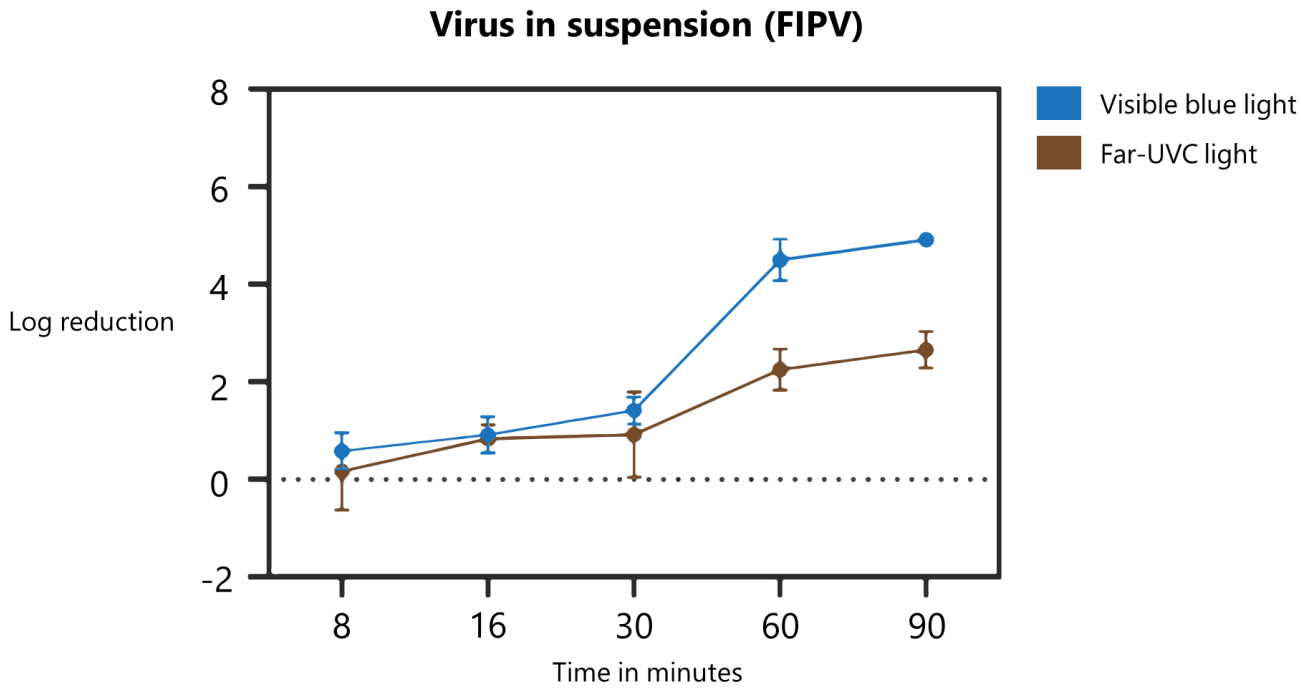
Blue light shown to destroy SARS-CoV-2 surrogate (FIPV)
>99,99% (>4log) reduction in 1,5 hours

Several new (2020-2021) studies show that especially lipid-enveloped viruses, such as Coronaviruses (including SARS-CoV-2, cause of COVID-19 pandemic) and Influenza-A virus (a common cause of regular flu and sickness absence), are susceptible to visible blue light.

In fact, according to the studies, visible blue light inactivates the viruses already in minutes.



Log reductions achieved with a surrogate coronavirus FIPV (similar to SARS-CoV-2) in suspension; a comparison between blue light and Far-UVC [1]

Gardner A, Ghosh S, Dunowska M, Brightwell G. Virucidal Efficacy of Blue LED and Far-UVC Light Disinfection against Feline Infectious Peritonitis Virus as a Model for SARS-CoV-2. Viruses. 2021; 13(8):1436; doi: https://doi.org/10.3390/v13081436

Raveen Rathnasinghe, Sonia Jangra, Lisa Miorin, Michael Schotsasert, Clifford Yahnke, Adolfo García-Sastre: Lighting a better future: the virucidal effects of 405 nm visible light on SARS-CoV-2 and influenza A virus. bioRxiv 2021.03.14.435337; doi: https://doi.org/10.1101/2021.03.14.435337

R. De Santis, V. Luca, G. Faggioni, S. Fillo, P. Stefanelli, G. Rezza, F. Lista: Rapid inactivation of SARS-CoV-2 with LED irradiation of visible spectrum wavelenghts medRxiv 2020.06.18.20134577; doi: https://doi.org/10.1101/2020.06.18.20134577

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Spectral Blue® summary

- ❖ **Effective on ALL bacteria, molds and yeasts (over 2000 peer-reviewed scientifical studies available) as well as Coronavirus and Influenza-A**
- ❖ **Purifies both the air- and the surfaces (kills microbes, and reduces smell, odour and gases), all-in-one solution**
- ❖ **Unlike UV light (or chemical disinfectants) it´s safe for humans and materials (while still effectively killing microbes)**
- ❖ **World fastest safe and automatic disinfection metod (recently verified by Harvard Medical School*)**
- ❖ **Patented- and award winning technology, ”Seal of Excellence” issued by the European Commission**

*ref: Leanse LG, Goh XS, Cheng JX, Hooper DC, Dai T. Dual-wavelength photo-killing of methicillin-resistant Staphylococcus aureus. JCI Insight. 2020 Jun 4;5(11):e134343. doi: 10.1172/jci.insight.134343. PMID: 32493838; PMCID: PMC7308062.

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Thank you so much for you attention!

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Science

Additional material

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Most important references (science)

Antimicrobial blue light

Wang, Y., Wang, Y., Wang, Y., Murray, C. K., Hamblin, M. R., Hooper, D. C., & Dai, T. (2017). Antimicrobial blue light inactivation of pathogenic microbes: State of the art. Drug Resistance Updates. https://doi.org/10.1016/j.drup.2017.10.002

Hessling, M., Spellerberg, B., & Hoenes, K. (2017). Photoinactivation of bacteria by endogenous photosensitizers and exposure to visible light of different wavelengths - A review on existing data. In FEMS Microbiology Letters. https://doi.org/10.1093/femsle/fnw270

How photocatalytic coating aids in destroying microbes, VOCs and odours

Howard A. Foster, Iram B. Ditta, Sajnu Varghese & Alex Steele. Mini-Review: Photocatalytic disinfection using titanium dioxide: spectrum and mechanism of antimicrobial activity. Applied Microbiology and Biotechnology volume 90, pages 1847–1868 (2011). https://link.springer.com/article/10.1007/s00253-011-3213-7

Je-Wen Liou & Hsin-Hou Chang. Review: Bactericidal Effects and Mechanisms of Visible Light-Responsive Titanium Dioxide Photocatalysts on Pathogenic Bacteria. Archivum Immunologiae et Therapiae Experimentalis volume 60, pages 267–275 (2012). https://link.springer.com/article/10.1007/s00005-012-0178-x

Clinical study from operation room

Murrell LJ, Hamilton EK, Johnson HB, Spencer M. Influence of a visible-light continuous environmental disinfection system on microbial contamination and surgical site infections in an orthopedic operating room. Am J Infect Control. 2019 Jul;47(7):804-810. https://doi.org/10.1016/j.ajic.2018.12.002

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When choosing a disinfection solution
- what should you pay attention to?

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A hoax to make money or a valid disinfection solution – how to distinguish them?

Example to highlight the differences between unreliable data and a more convincing set of data.
The error bars in the graph to the right tells you that the data point consist of an average of at least three samples, which is much more reliable than showing results from just one sample as in the graph to the left. Please note also that the scales on the y-axis are different in the two graphs. It is very easy to make disinfection seem more dramatic by changing the scales on the y-axis.

The whole article is available on LinkedIN: https://www.linkedin.com/pulse/hoax-make-money-valid-disinfection-solution-how-them-camilla-h%25C3%25B6glund/?trackingId=Yna22E38RjGehv6qqfgsmg%3D%3D

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Blue light and UV light – what is the difference?

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Blue light and UV light are two very different photon disinfection technologies

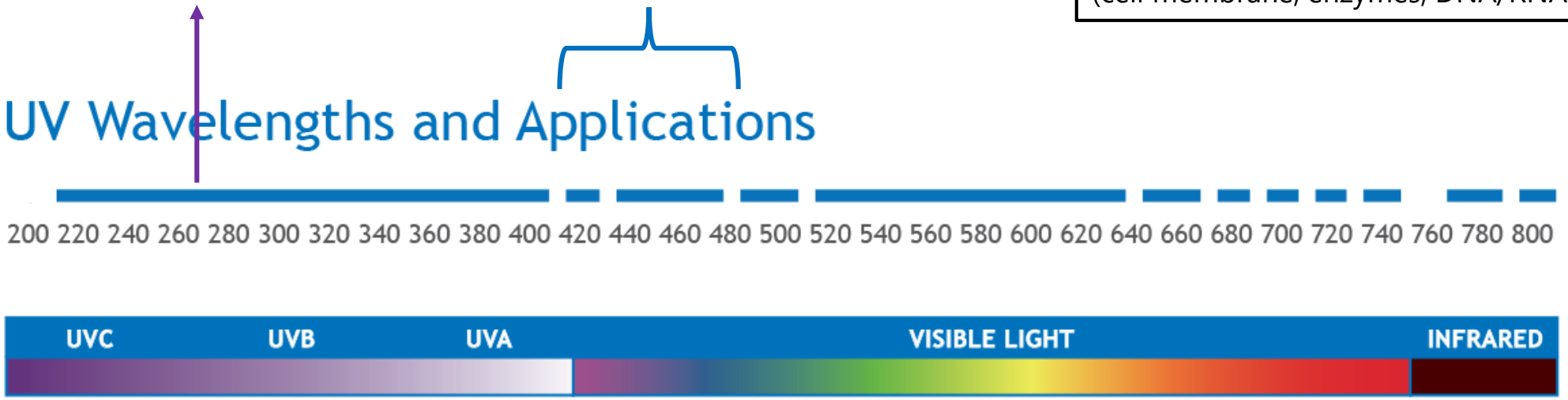
LT WiSDOM DS
- UVC (265 nm)

Spectral Blue ®
- Antimicrobial blue light

Mechnisms of inactivation of microbes are very different!

UVC light destroys DNA/RNA by breaking chemical bonds

Blue light initates a reaction cascade that results in production of various ROS (reactive oxygen species). These have the ability to destroy anything inside the cell (cell membrane, enzymes, DNA/RNA, proteins etc)



https://www.phoseon.com/uploads/content_image/Available-Wavelengths-Applications-Update.png

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Which disinfection solution should you choose?

Technology feature	Blue light	UV light	Chemcial (vapor)	Chemcial (liquid)
Disinfection time	15min-hours	minutes	20min - 120min	2-15min (contact time) + manual wiping
Manual labour	None	None – some (some UV-machines requires transfer between rooms)	Moderate	Extensive
Safety (humans)	Yes	No	No	No
Safety (materials)	Yes	No	No	No
Safety (enviroment)	Yes	Yes/no (Depending on type of light sourse. Many commonly used UV-light sourses contain mercury)	No	No
Lifetime	10 years	1-5 years	-	-
Triggering resitance development in microbes (superbugs)	No (reasons to belive this will not be a problem in the forseable future, maybe never)	Possibly (some evidence exists)	Yes	Yes
Biofilm – ability to penetrate and destroy inside?	Yes	No	To some degree	Yes

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Microbes stay alive on surfaces for long periods

- Most gram positive and negative bacteria (Campylobacter, E.Coli, Salmonella, Listeria) can survive on dry surfaces for **several months**.
- *Candida albicans* can survive for **up to 4 months**, other yeasts from 14 days to five months.
- Viruses from respiratory tract (corona, coxsackie, influenza, SARS) survive **a few days**.
- Viruses from gastrointestinal tract (astrovirus, HAV, polio or rota virus) survive approximately **2 months**.
- Blood borne viruses (HBV or HIV) can survive **more than a week**.

Without proper means of disinfection microbes causing infections will stay at surfaces **for months**.

With better hygiene practices, **safety can be significantly improved**.

Ref: Kramer et al 2006: How long do nosocomial pathogens persist on inanimate surfaces? A systematic review. *BMC Infectious Diseases* 2006, 6:130
doi:10.1186/1471-2334-6-130

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Over 2000 peer-reviewed studies: Effective on all microbes

Cause of infection in ECDC study (% of all cases)	Microbe tested in blue light study	Wavelength	Dose	Reduction		Reference
Escherichia coli (15.9%)	*Escherichia Coli*	405 nm	65 J/cm^2	> 99.9 %	3.6 $\log_{10}$	(Barneck et al., 2016)
Staphylococcus aureus (12.3%)	MRSA	470 nm	55 J/cm^2	> 99.999 %	> 5 $\log_{10}$	(Bumah et al., 2015; Bumah, Masson-Meyers and Enwemeka, 2015)
Enterococcus spp. (9.6%),	*Enterococcus faecalis*	405 nm	886 J/cm^2	> 99.99 %	4.7 $\log_{10}$	(Gupta et al., 2015)
Pseudomonas aeruginosa (8.9%)	*Pseudomonas aerunginosa*	405 nm	55 J/cm^2	> 99.9 %	3.6 $\log_{10}$	(Barneck et al., 2016)
Klebsiella spp. (8.7%)	*Klebsiella pneumoniae*	405 nm	180 J/cm^2	> 99.9 %	3.9 $\log_{10}$	(Maclean et al., 2009)
Coagulase-negati ve staphylococci (7.5%)	*Staphylococcus epidermidis*	405 nm	118 J/cm^2	> 99.999 %	5.1 $\log_{10}$	(Gupta et al., 2015)
Candida spp. (6.1%)	*Candida albicans*	415 nm	70 J/cm^2	> 99.999 %	5.4 $\log_{10}$	(Zhang et al., 2016)
Clostridium difficile (5.4%)	*Clostridium difficile*	405 nm	48 J/cm^2	> 99.99 %	4 $\log_{10}$	(MacLean et al., 2013)
Enterobacter spp. (4.2%)	*Enterobacter cloacae*	400 nm	92 J/cm^2	> 90 %	1 $\log_{10}$	(Halstead et al., 2016)
Proteus spp. (3.8%)	*Proteus vulgaris*	405 nm	144 J/cm^2	> 99.99 %	4.7 $\log_{10}$	(Maclean et al., 2009)
Acinetobacter spp. (3.6%).	*Acinetobacter baumannii*	405 nm	108 J/cm^2	> 99.99 %	4.2 $\log_{10}$	(Maclean et al., 2009)

Most common causes of HAIs (ECDC 2011) vs. blue light alone.
The Spectral Blue photocatalytic coating is required to eliminate viruses and spores.

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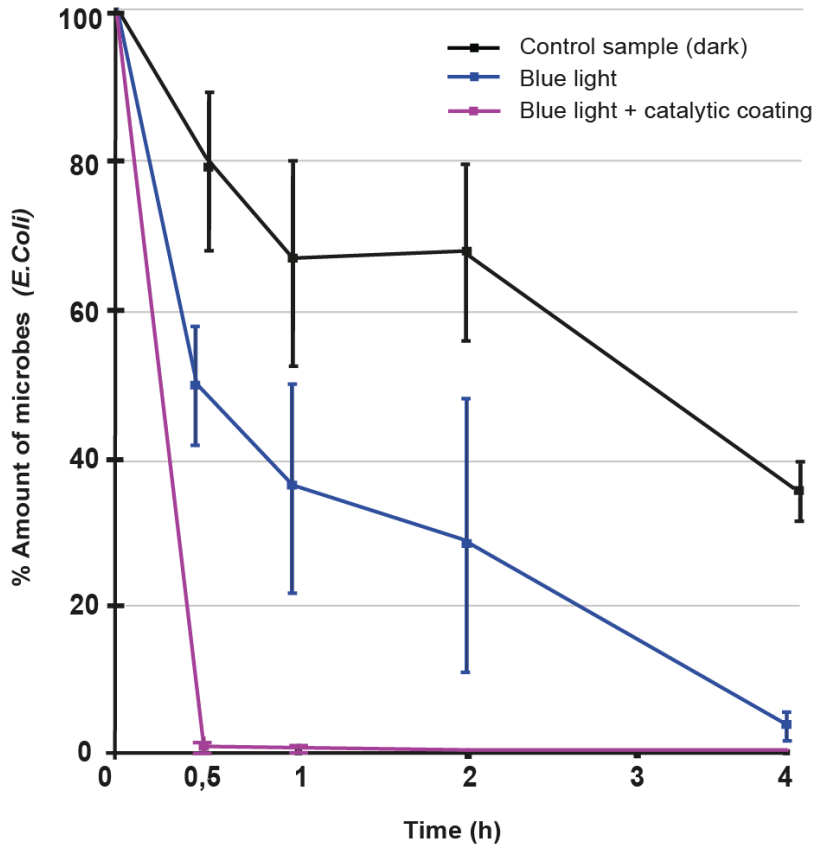
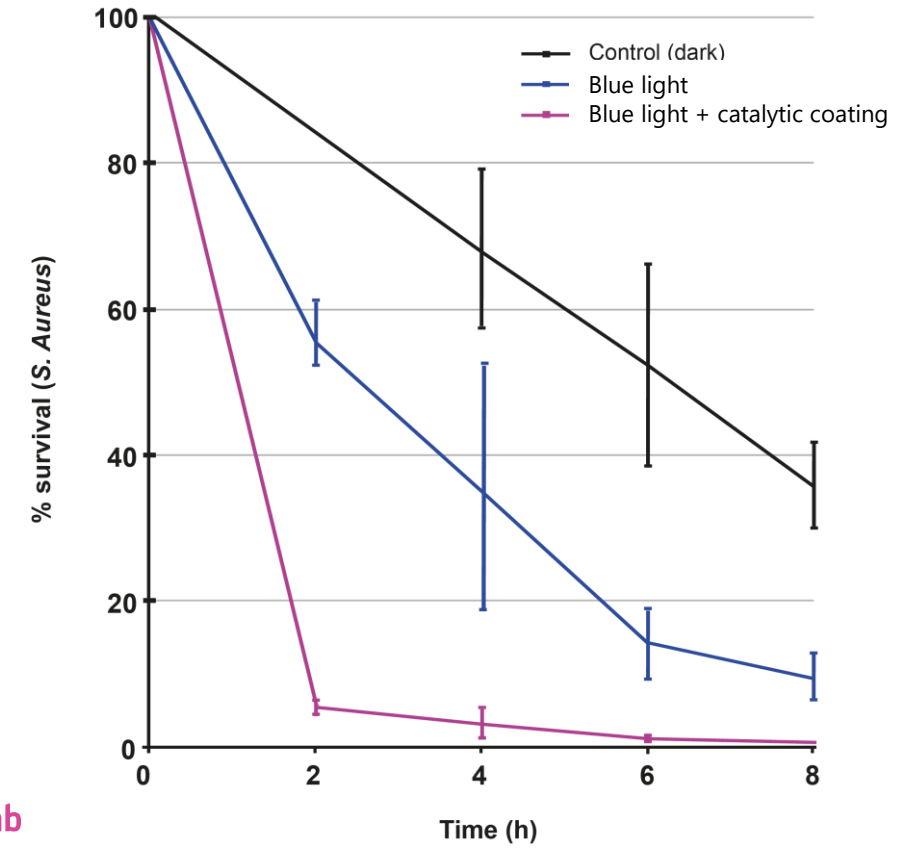
3rd party lab testing low intensity Spectral Blue® (simulating worse case scenario)

Spectral Blue® vs. E.coli



Spectral Blue® vs. MSSA/MRSA



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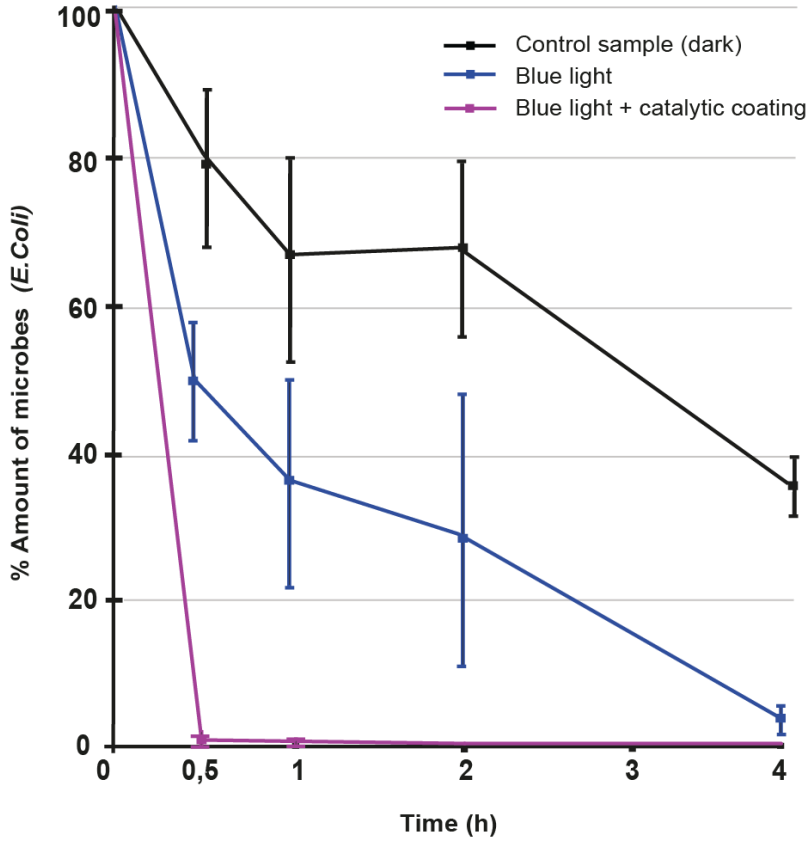
Spectral Blue® vs. E. coli

In summer 2020, laboratory tests were conducted at the FINAS accredited MetropoliLab to determine the efficiency of LED Tailor's blue light disinfection devices in inactivation of E.Coli (ATCC 25922).

The bacteria were spread out on the bottom of plastic petri dish and irradiated with low density blue light (0,7mW/cm2) under regular office conditions. Each test result contains three parallel samples from each point of analysis. Error bars show SD (standard deviation).

99% reduction was achieved already at 30 minutes



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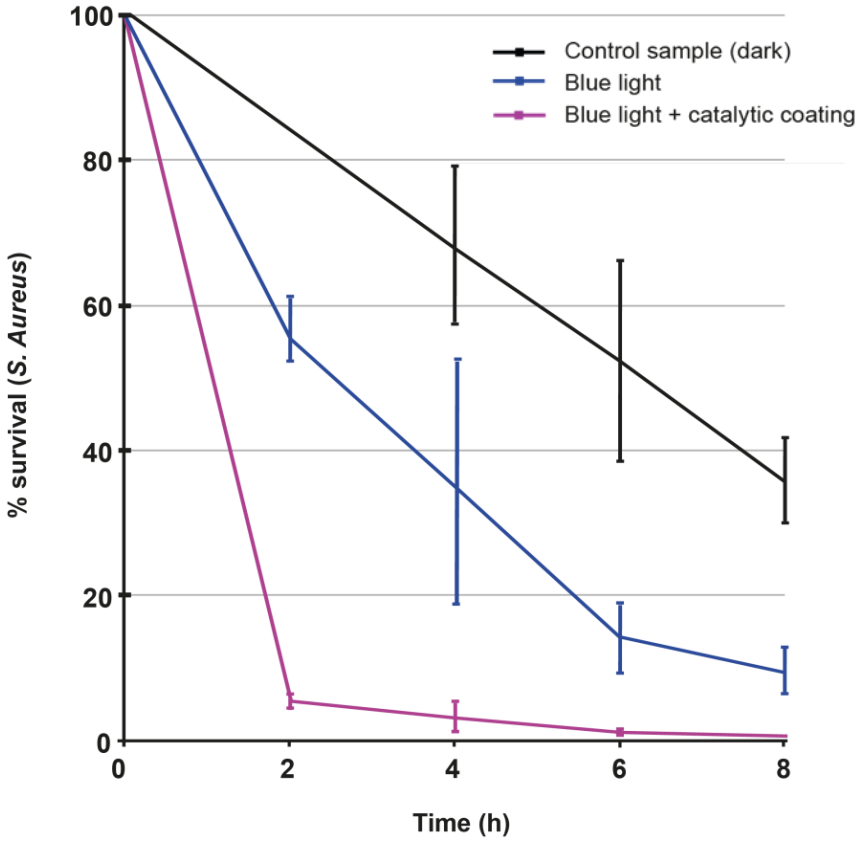
Spectral Blue® vs. MSSA/MRSA

In spring 2019, laboratory tests were conducted at the FINAS accredited MetropoliLab to determine the efficiency of LED Tailor's blue light disinfection devices in inactivation of Staphylococcus aureus (ATCC 6538).

The bacteria were plated on a regular melamine tabletop and irradiated at low intensity (blue light 0,7 mW/cm^2). The results were confirmed by conducting three separate tests, with each test utilizing three parallel samples from each point of analysis. Error bars show SD (standard deviation).

99% reduction was achieved already at 6 hours



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