

# Contamination Control in Pharma Production with UVD Robots



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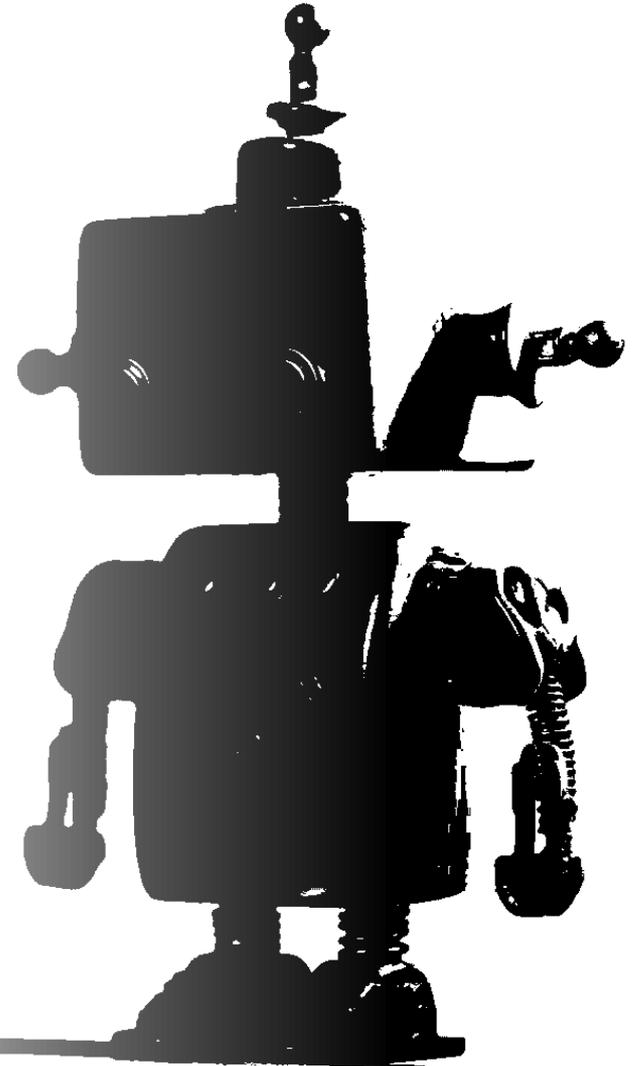
# Evaluation of a UVD Robot

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Professor Val Edwards-Jones

Emeritus Professor of Medical Microbiology,  
Manchester Metropolitan University

Essential Microbiology Ltd



# Antimicrobial Resistance - Biggest Global Threat

- Biggest threat to modern medicine as we know it.
- Most well superbugs are MRSA (methicillin resistant *Staphylococcus aureus*), *Clostridium difficile* and most recently CPE (carbapenemase resistant Enterobacteriaceae )
- Gram-negative bacteria that are resistant to the carbapenem class of antibiotics, considered the drugs of last resort for such infections.

# Environmental decontamination

## **Environment** – cleaning / decontamination

- *C difficile* has been isolated from the environment (dust, high touch areas e.g. telephone consoles, mattresses, etc). Other Gram positive organisms are found in similar areas
- Gram negative organisms (CPE) found in wet areas (sinks, drains, etc).
- Incubators and other equipment etc can become contaminated and very difficult to clean with disinfectants.
- Can be left with an ongoing contamination problem.

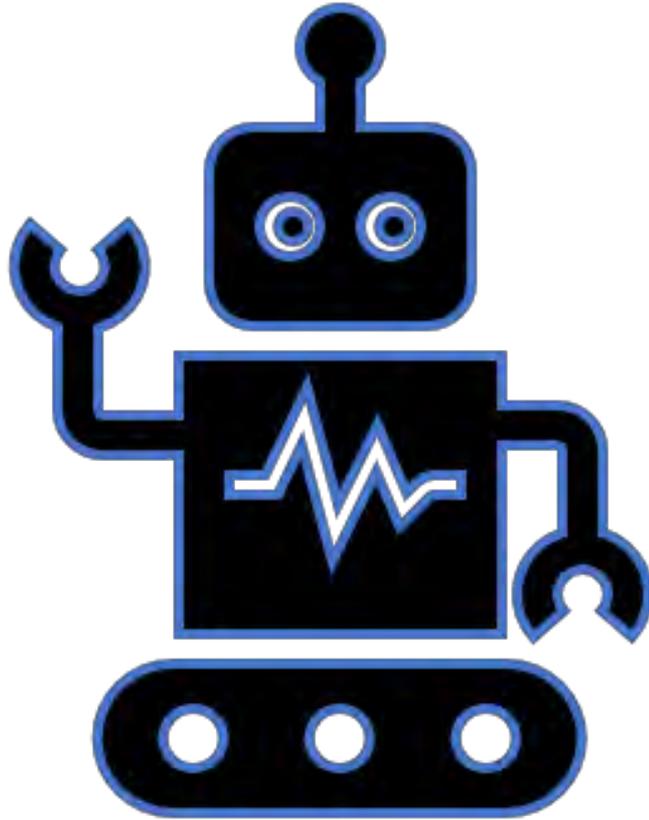
## **Aerosols**

- Fogging / Hydrogen peroxide
- UVC

# UV-C

## How it works

- UV rapidly causes irreparable damage to the DNA /RNA by formation of pyrimidine dimers (e.g. thymine base pairs next to each other in genetic sequences, bond together) which disrupts the strand killing the cell.
- UV light used in microbiology cabinets for many years where aseptic techniques are required to reduce contamination.
- Used to decontaminate water supplies.
- Used to decontaminate the environment.



# The UVD robot

- UVC light emission in a room to eradicate HAIs in the environment is a well established technique, however, **shadowing** can be problematic and reduce efficacy.
- In a real life situation, for example a patient room it can be impossible to place the UV system at a 1m distance from potential contaminants / superbugs.
  - Proximity from light source to those bugs is critical.
- The ability for the robot to autonomously move around enables it to radiate onto the microbes at the shortest distance and this is a massive advantage.

# Previous studies

- Previous studies undertaken in Denmark demonstrated that the UVD robot reduced bacterial numbers of
  - *Staphylococcus aureus*
  - *Enterococcus hirae*
  - *Pseudomonas aeruginosa*
  - *E. coli*
- **By greater than 5 log in 5 minutes.**
  - For example from 100000 cells to 1 cell.
  - 1000000 to 10 cells
- **What does this mean for the environment?**
- Low environmental numbers are less likely to cause a problem of risk of infection from the environment
- High touch areas may have high numbers of bacteria/viruses on the surface (perhaps over 100000 per sq cm ) and many are removed during terminal cleaning by antiseptics but sometimes not all.

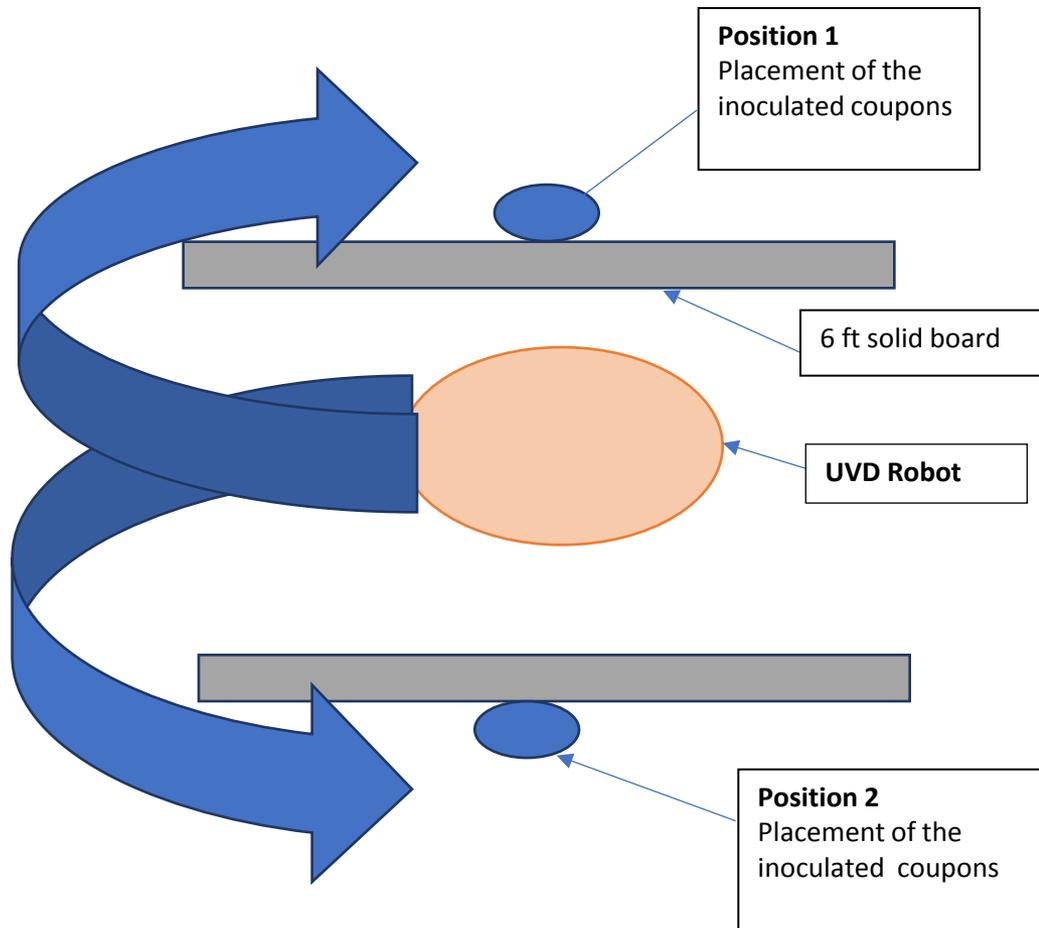
# Assessment of microbial reduction of common HAIs using UVD robot in a UK accredited laboratory

ASSESSMENT OF UVD ROBOT AGAINST REDUCTION OF MULTI DRUG RESISTANT KLEBSIELLA PNEUMONIAE, ACINETOBACTER BAUMANII AND CLOSTRIDIUM DIFFICILE ON SURFACES.

- Stainless steel discs (2 cm diameter discs) 304 with grade 2b finish on both sides were inoculated with 50ul of approx. 1-10 million colony forming units /ml of each organism. (n=3)
- They were dried to the coupons for 30minutes.
- Triplicate coupons were left exposed to UV light in two **shaded** positions within the room. Triplicate coupons (controls for each run/position) were placed in the same position but wrapped in tin foil so that the UV light could not reach them
- The robot was programmed to move within 1 metre of the coupons and the coupons were exposed to UV light for different periods ranging from 3 mins to 15 mins.
- UV indicators were placed at the same positions and monitored

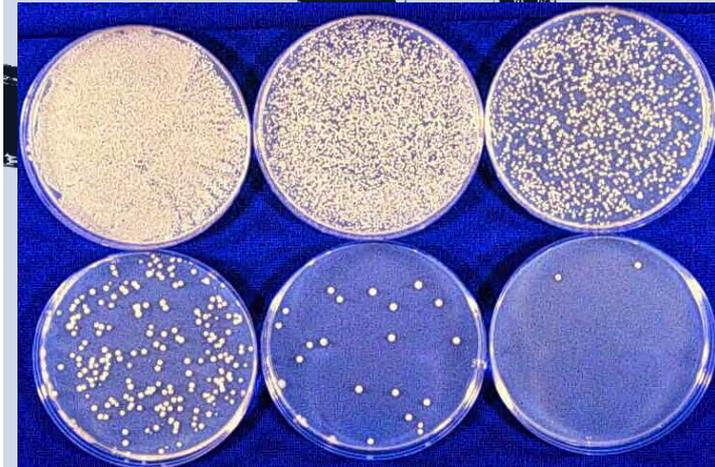
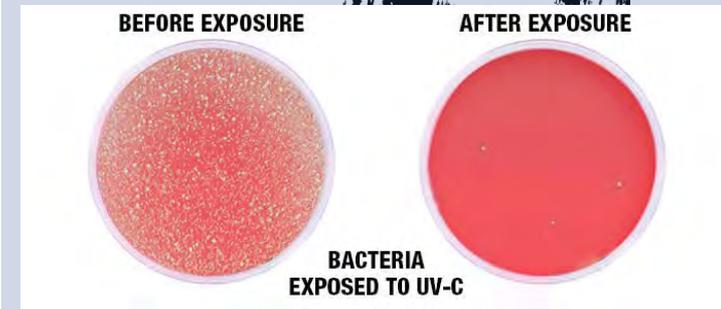


# Diagram of the room used



# Study Results

- *Klebsiella pneumoniae* (NCTC 13443)  
NDM-1 metallo beta-lactamase – (CPE)
  - **6 log reduction in 3 minutes at both positions**
- *A baumannii* (NCTC 12156)
  - **7 log reduction in 3 minutes at both positions**
- *C difficile* spores (NCTC 11209)
  - **4 log reduction in 3 mins**
  - **4.5 log at 5 mins at both positions**



4 log reduction

# UV indicators



1000 Joules per square metre were received within a minute.



Previous studies have shown that :-

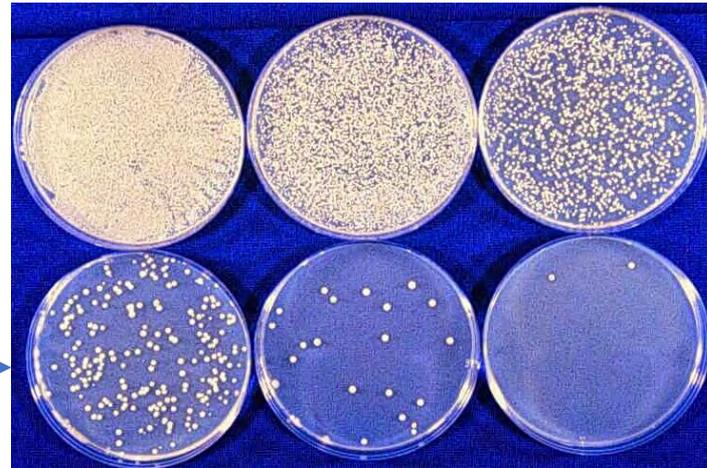
MRSA requires 192 joules for a log 6 reduction  
*E coli* requires 180 joules for a log 6 reduction  
Vegetative *C difficile* requires 240 joules for a log 4 reduction

# Second study – drive by

- The robot moved past the test discs (with *K. pneumoniae* ) without stopping at a distance of 1m.
- The robot moved at approximately 10cm/second and the total distance moved was approximately 4m.

- **Results: 3 log reduction achieved**

3 log reduction →



# Contamination issue in main incubator

- tried everything to decontaminate an incubator of a mould
- Borrowed UVD robot for the day
- Operated the robot in the lab for a few hours.
- Opened the incubator and left it operating through the water trap (which had been cleaned several times.
- Left the robot continually emitting UVC a number of times
- NO further problems since.

# Conclusion

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The UVC robot allowed movement around the room there was limited shadowing

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*C. difficile* showed a 4.5 log reduction after 5 minutes

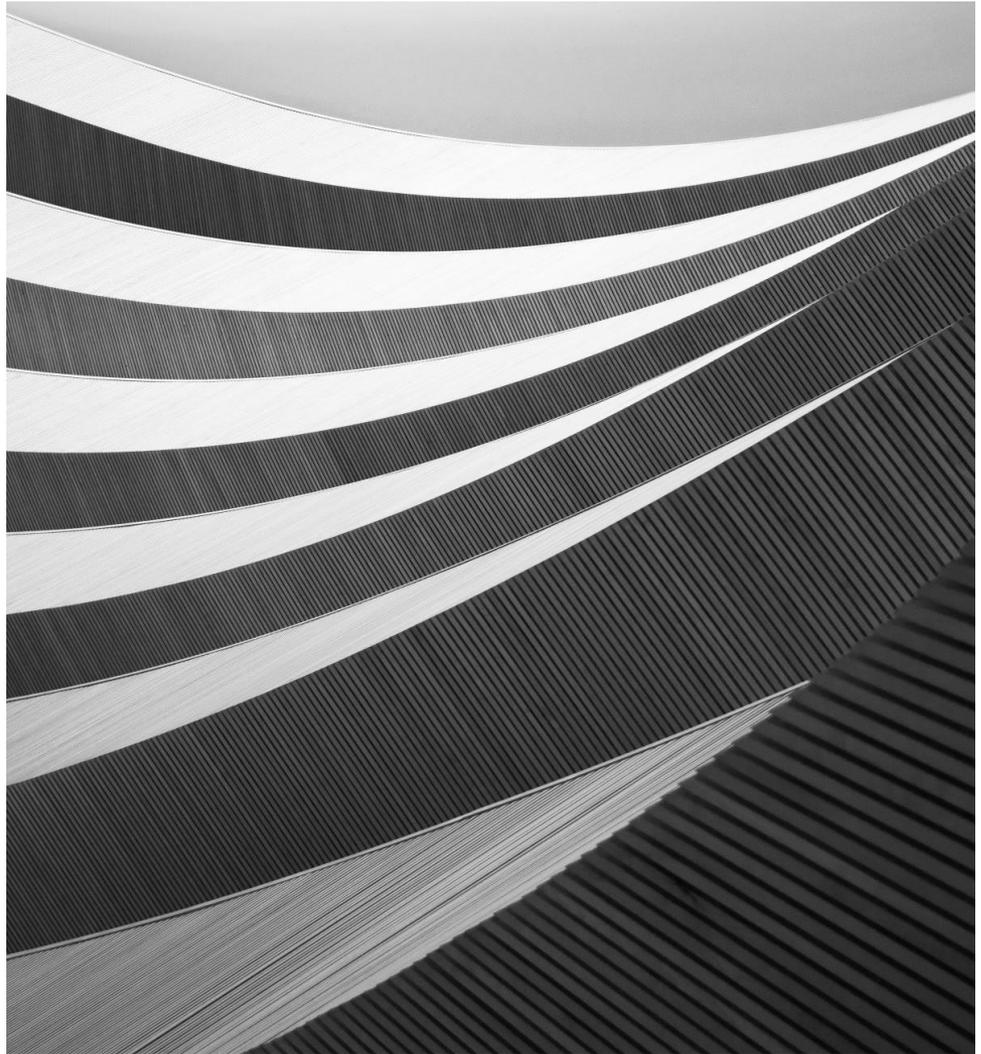
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The two Gram negative bacteria showed greater than 6 log reduction within 3 minutes of exposure.

A 3 log reduction was achieved when the robot drove by the samples.

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UV decontamination of the environment is an excellent system for ensuring reduction in spread of infection from the environment within the hospital environment.





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Quality Equipment Solutions



## UVD ROBOTS

INFECTION PREVENTION

## Deploying UVD Robots for contamination control in the Pharmaceutical industry

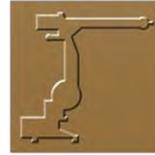
The Pharma industry presentation



The iconic 'Army of robots' picture appeared in over 200 media articles reporting on the Chinese Authority's decision to deploy UVD Robots against COVID-19



## UVD Blue Ocean Robotics



**IERA AWARD.**  
Innovation and Entrepreneurship in Robotics and Automation



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## UVD The 'allround' solution

- Initially developed in 2015 in cooperation with the Danish Healthcare Authority to combat rising levels of hospital acquired infections (HAIs) in Danish hospitals
- A highly mobile, fully autonomous self-driving mobile robot platform (AMR) with integrated UVC light disinfection system in order to reach all critical parts of a room/area
- 3rd generation technology with sales to hospitals and non-healthcare facilities in over 70+ countries
- Disinfects parallel both surfaces and the air
- The only disinfection system available, clinically proven to disinfect effectively while 'on the move'

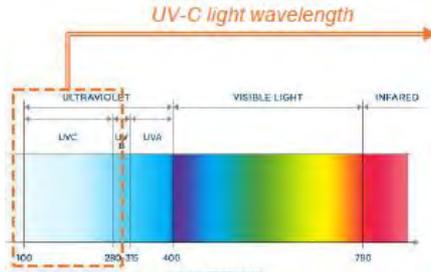


The UVD Robot is now 2nd generation technology, from conception and design in 2015 (right), prototype model A (left) in 2016 to model B in 2018 (middle)

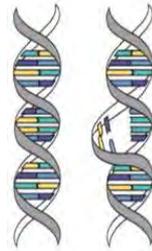
## UVD How UV-C light disinfects

### Ultraviolet Germicidal Irradiation (UVGI)

- A well proven disinfection method.
- Light photons are absorbed by the DNA (bacteria) or RNA (virus) causing irreparable damage.
- This interrupts normal cellular functions and renders the organism unable to multiply.
- An organism that CANNOT multiply CANNOT infect.



254nm in the UV-C range is considered to have the highest germicidal effect



DNA/RNA is irreparably damaged after exposure to UV-C light



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## **UVD** Inactivating COVID-19

How much UV-C light is proven to be required?

### **UV-C at 254 nm testing on COVID-19 on surfaces**

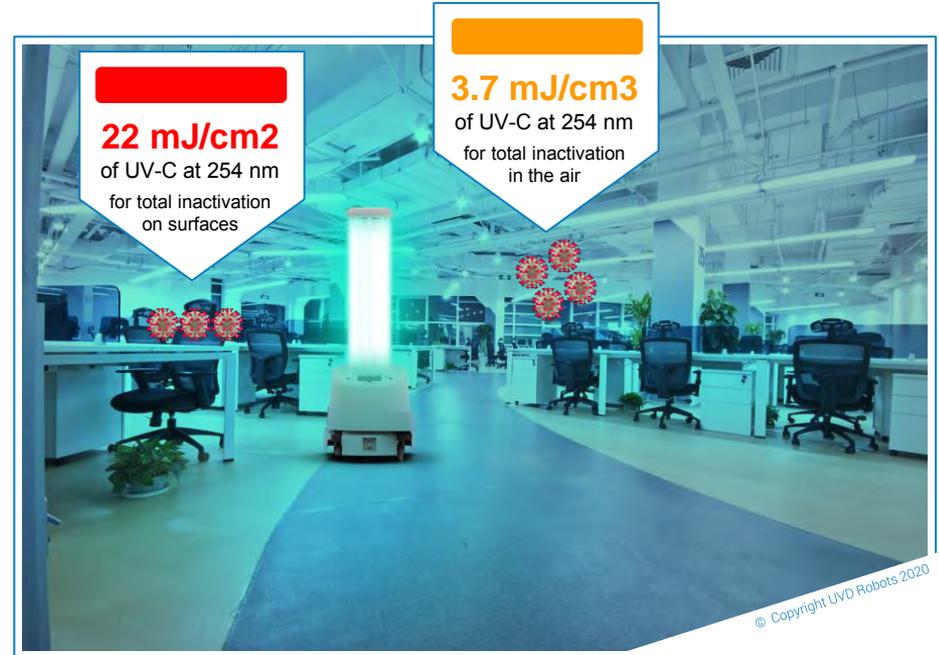
In cooperation with The Emerging Infectious Disease Department at Boston University in the United State, the supplier of the UV-C lamps on the UVD Robot, tested the efficacy of their 254 nm UV-C lamps on COVID-19.

*'The team applied a dose of 5mJ/cm<sup>2</sup>, resulting in a reduction of the SARS-CoV-2 virus of 99%. Based on the data, it was determined that a dose of 22 mJ/cm<sup>2</sup> will result in a reduction of 99.9999%.'*

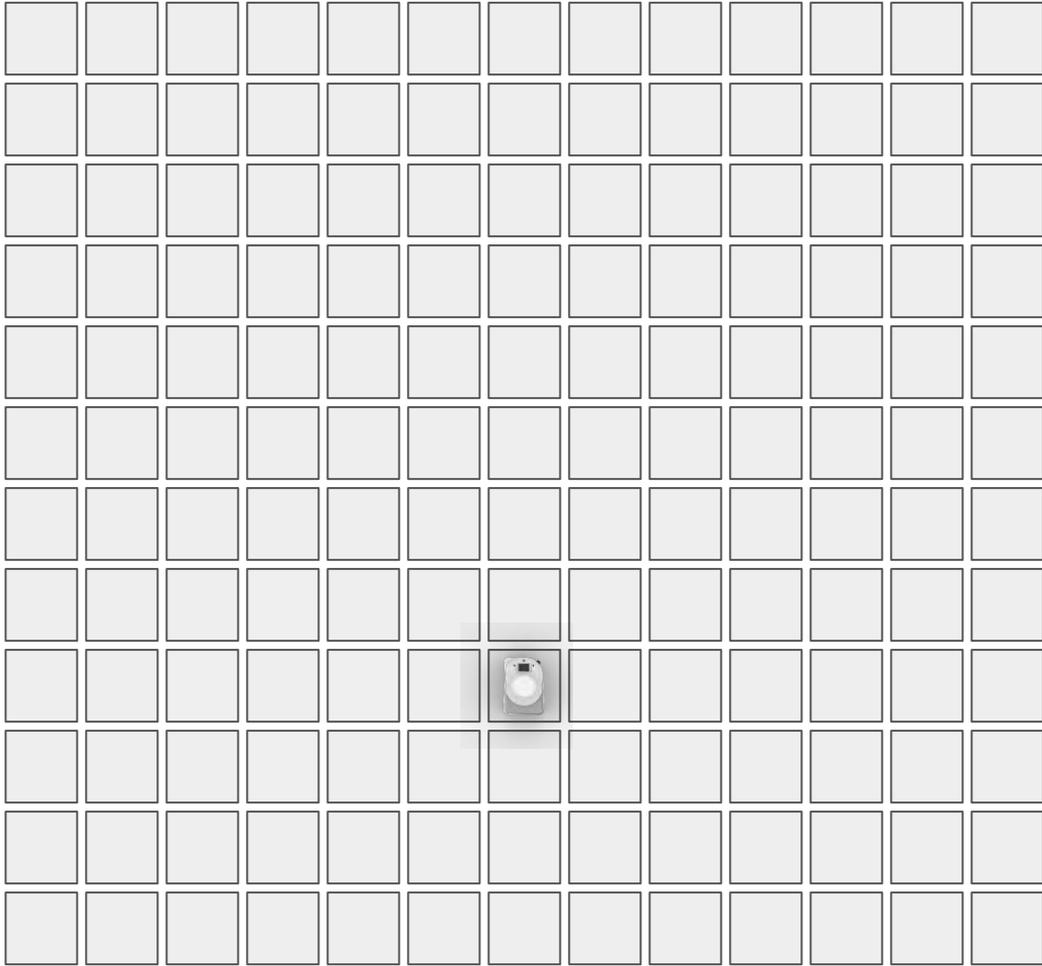
Extract taken from the study

### **UV-C at 254 nm testing on COVID-19 in the air**

Parallel to the testing in The United States, the University of Milan in Italy have confirmed that at the wavelength of 254 nm, a much lower dosage of 3.7mJ/cm<sup>3</sup> is required to inactivate the virus in the air.



In July 2020, scientists confirmed it is more than likely that COVID19 is aerosol which means the virus can linger in the air for long periods of time. In other words, the disinfection of surfaces alone will not suffice

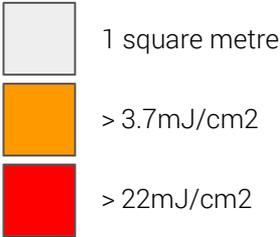


## UVD Inactivating COVID-19

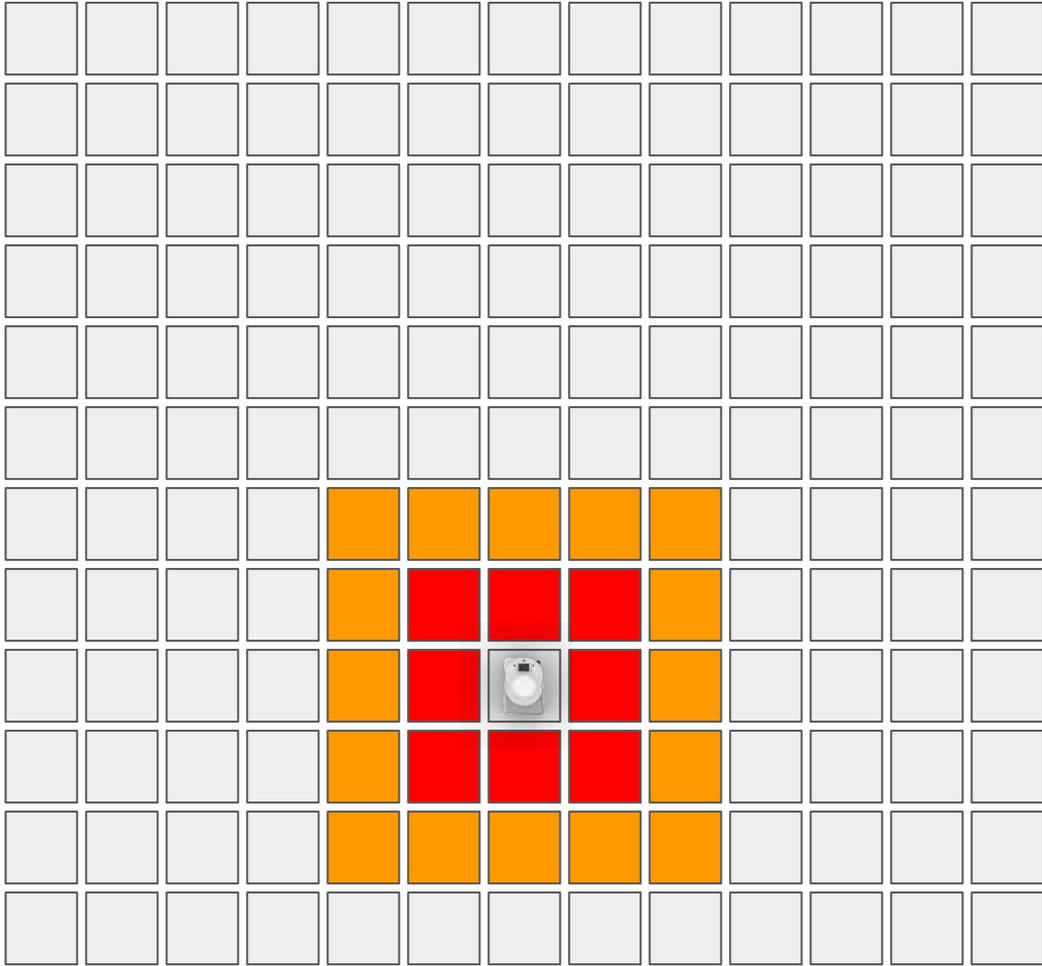
What is the effective coverage?

Disinfection speed of 0.1m/second

Coverage at **0** seconds



Accumulated dosage calculated based on the 10 second totals for the disinfection speed stated. They are 27mJ/cm<sup>2</sup> exposure at 1m, 6.75mJ/cm<sup>2</sup> at 2m, 3mJ/cm<sup>2</sup> at 3m, 1.69mJ/cm<sup>2</sup> at 4m, 1.1mJ/cm<sup>2</sup> at 5m, 0.75mJ/cm<sup>2</sup> at 6m, 0.55mJ/cm<sup>2</sup> at 7m and 0.42mJ/cm<sup>2</sup> at 8m



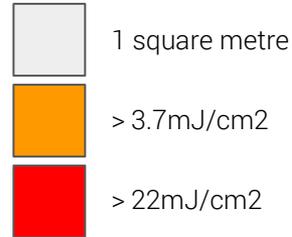
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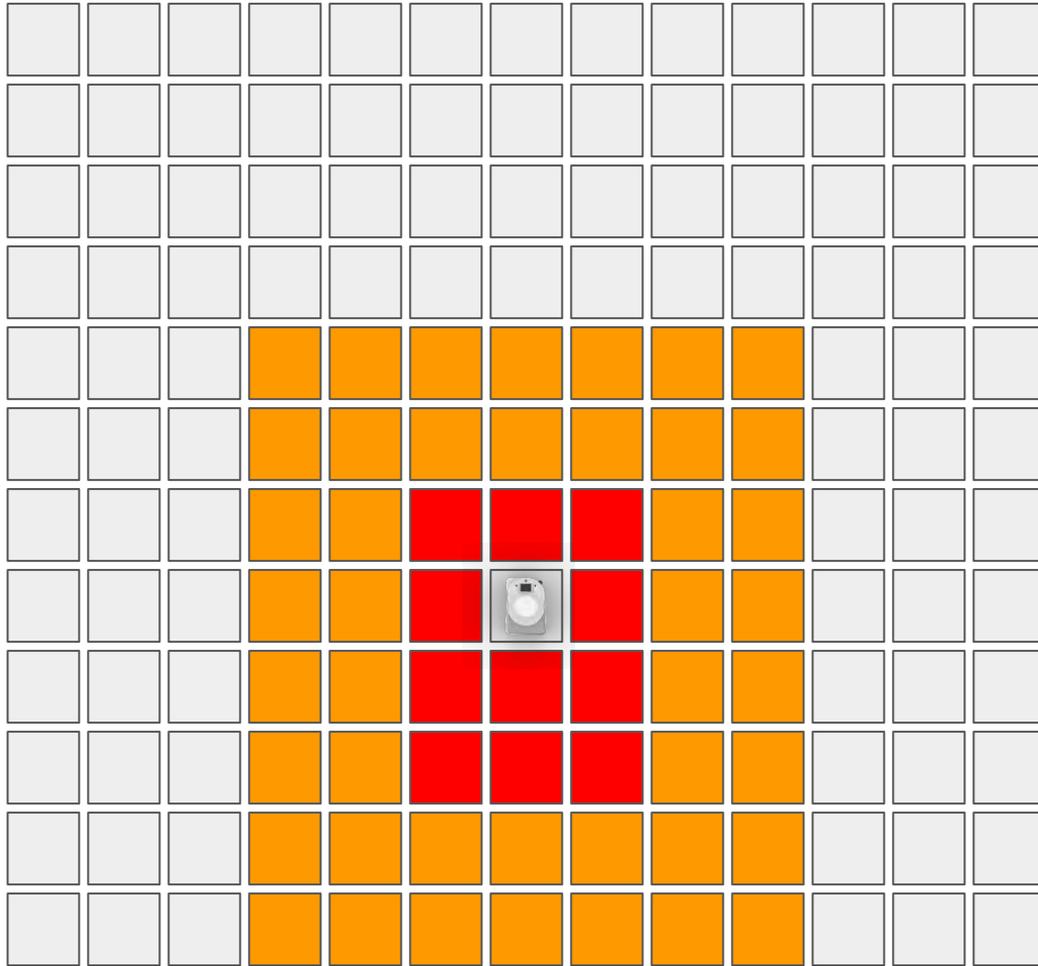
## UVD Inactivating COVID-19

What is the effective coverage?

Disinfection speed of 0.1m/second

Coverage at **10** seconds





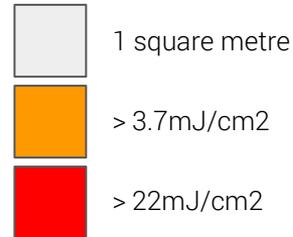
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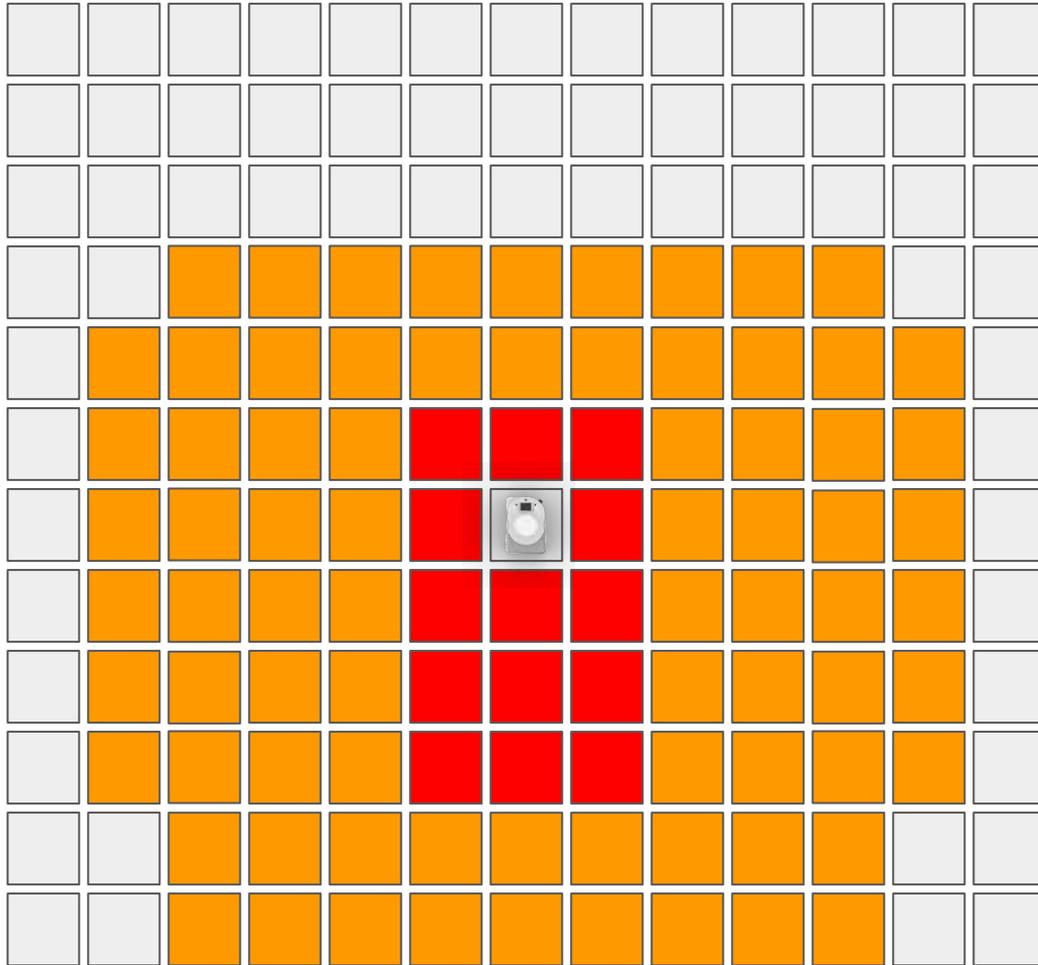
## UVD Inactivating COVID-19

What is the effective coverage?

Disinfection speed of 0.1m/second

Coverage at **20** seconds





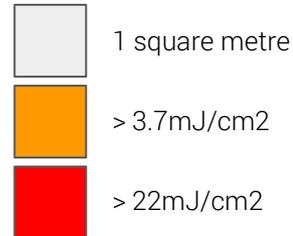
Accumulated dosage calculated based on the 10 second totals for the disinfection speed stated. They are 27mJ/cm2 exposure at 1m, 6.75mJ/cm2 at 2m, 3mJ/cm2 at 3m, 1.69mJ/cm2 at 4m, 1.1mJ/cm2 at 5m, 0.75mJ/cm2 at 6m, 0.55mJ/cm2 at 7m and 0.42mJ/cm2 at 8m

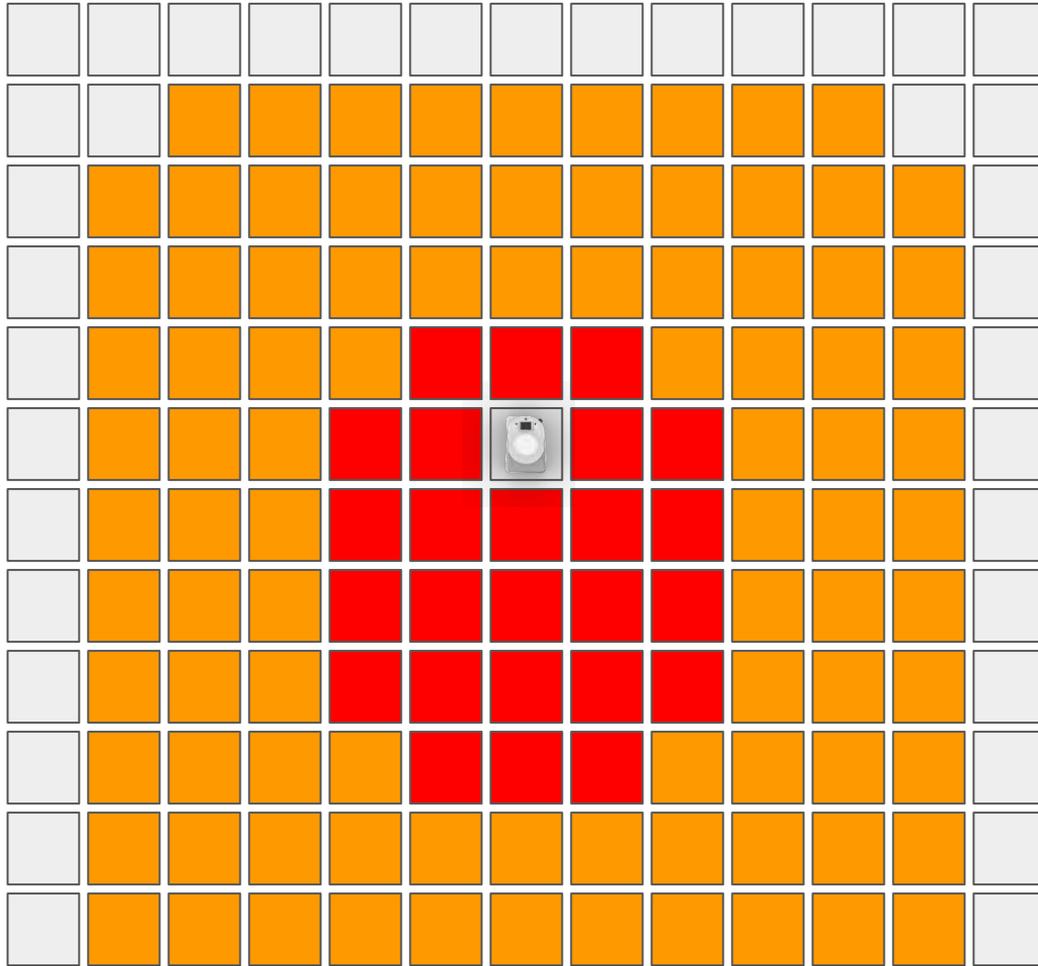
## UVD Inactivating COVID-19

What is the effective coverage?

Disinfection speed of 0.1m/second

Coverage at **30** seconds





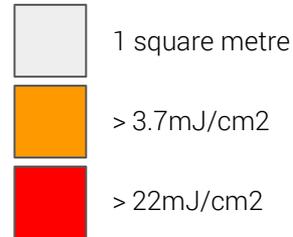
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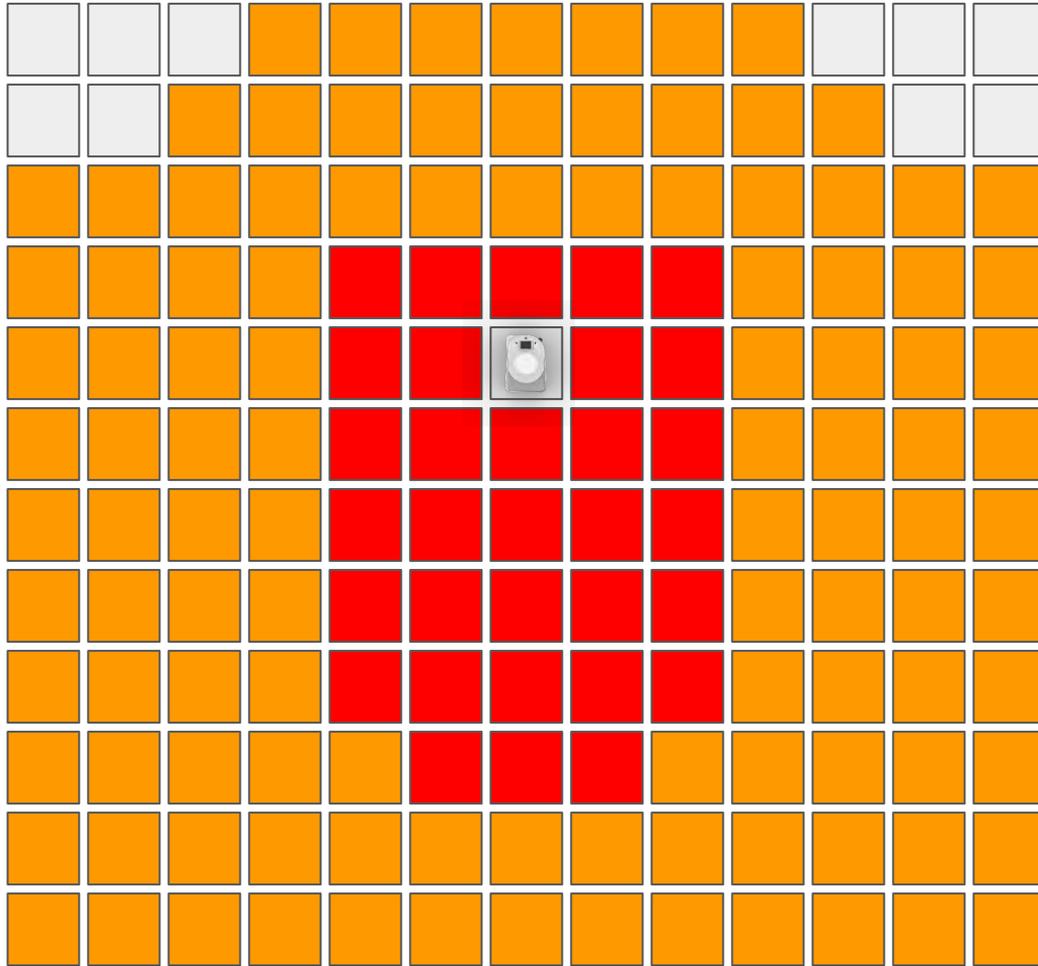
## UVD Inactivating COVID-19

What is the effective coverage?

Disinfection speed of 0.1m/second

Coverage at **40** seconds





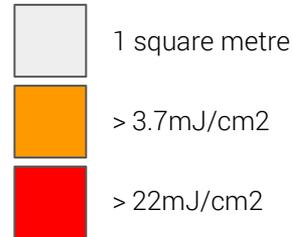
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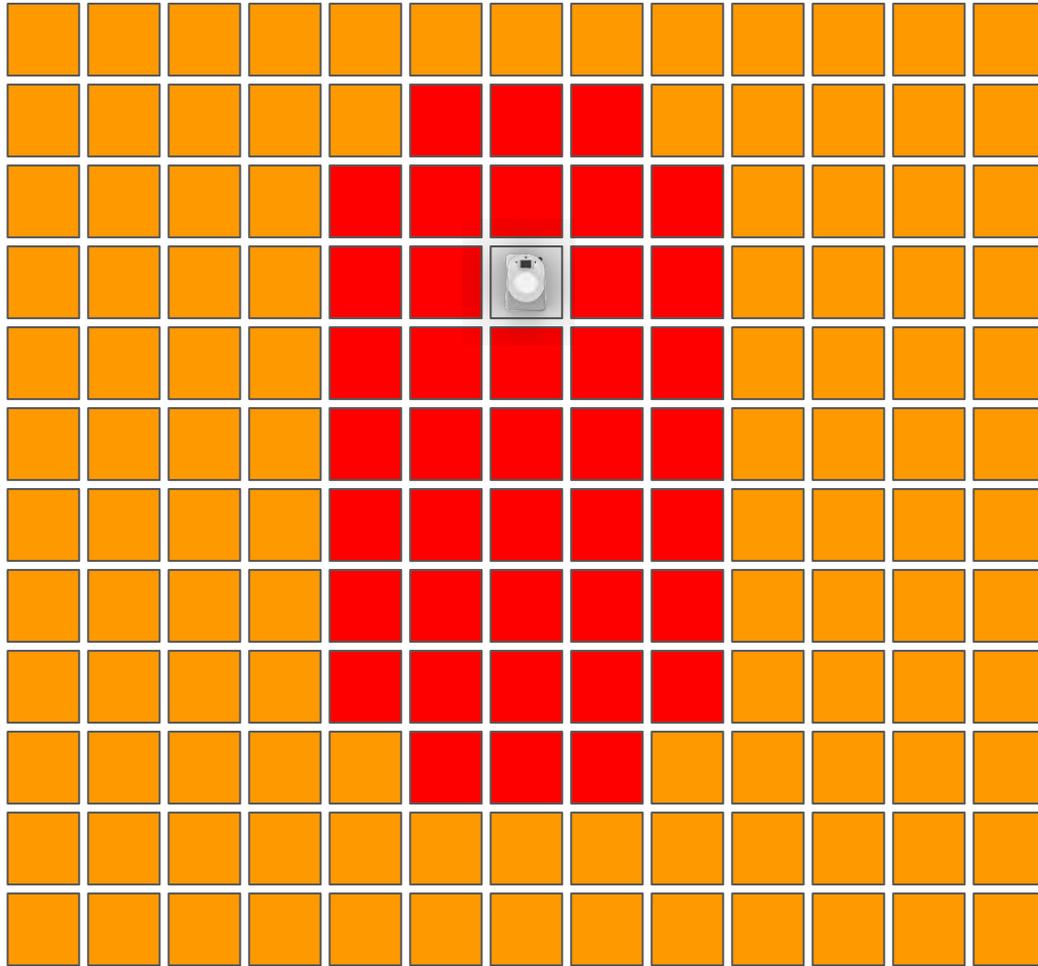
## UVD Inactivating COVID-19

What is the effective coverage?

Disinfection speed of 0.1m/second

Coverage at **50** seconds





Accumulated dosage calculated based on the 10 second totals for the disinfection speed stated. They are 27mJ/cm2 exposure at 1m, 6.75mJ/cm2 at 2m, 3mJ/cm2 at 3m, 1.69mJ/cm2 at 4m, 1.1mJ/cm2 at 5m, 0.75mJ/cm2 at 6m, 0.55mJ/cm2 at 7m and 0.42mJ/cm2 at 8m

## UVD Inactivating COVID-19

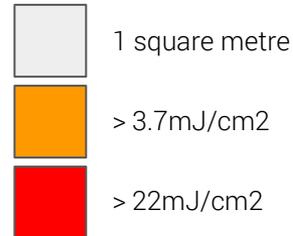
What is the effective coverage?

Disinfection speed of 0.1m/second

Coverage at **60** seconds

Air coverage 156 m<sup>2</sup> / min - 9,360 m<sup>2</sup> / hour

Surface covers 41m<sup>2</sup> / min - 2,460m<sup>2</sup> / hour



## UVD The robotic advantage

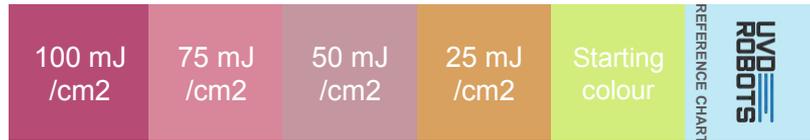
### Validated test result, Industry 4,0 ready ( pic 1)

The UVD Robot has advantages is:

- Receive a validated disinfection report
- Check if each disinfection points has been completed
- Ready for Industry 4.0

### Validation stickers ( pic 2+3)

- Yellow: Starting color
- Pink/Red: Result after drive-by-disinfection (75-100 mJ/cm<sup>2</sup>)
- SWAP-test has been done on Av-screens
  - 238 ATP pre UV-disinfection
  - 115 ATP post UV-disinfection (51%)



Pic 1



Pic 2+3



## **UVD** Pharma Robot-World Launch

- Global challenge - Contamination Control
- Bacterias, viruses can cause devastating damages - to production and personnel
- Pharma sites globally have reached out and asked for a robot version specifically for CEAs
- The solution must be able to disinfect various parts of the site and the air
- The solution must secure Pharma production up to hospital grade disinfection level



**NOV**  
**12**

SAVE THE DATE

**LIVE WEBINAR**  
**HOW TO USE UVD ROBOTS**  
for contamination control in Pharmaceutical Production

16.00 CET  
LIVE ON LINKEDIN

**UVD  
ROBOTS**  
INFECTION PREVENTION

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## **UVD** World Launch – Pharma version

- UVD Robots started a joint project with Danish Global Pharma Producer Novo Nordisk to develop this robot
- The robot is developed for Cleanroom level C/D, ISO 7/8 or FED STD 10 000/100 000 – first in the world
- It comes with all standard features plus modified Pharma features
- Further development/additional Pharma specific features can be provided in cooperation with the purchaser
- UVD Robots can offer Global Partnerships/Corporate Agreements via our global network of solution providers



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## UVD Pharma Robot – HW features

- PIR=Passive Infrared Sensor - up to 12 m distance for human detection
- Unpainted smooth plastic cover easy to clean and no paint to peel off (HA, Spor-Klenz, Pro-Chlor proven)
- New design of wheels with a sealed but easy-to-clean construction
- Stainless steel buttons and bridging parts
- Stainless steel clips holding the lamps
- Tablet cover in a robust, easy-to-clean and unpainted design



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## UVD Pharma Robot – SW features

- Can communicate with automatic door openers
- Internal WIFI connection between robot and tablet – no need go on external WIFI
- 3 level built-in security layers for personal security
- Development of features based on clinical data, clinical reports/studies
- Validation procedures/validated reports
- UI/Workflow based on user experiences
- Cybersecurity-validated with highest rate
- 21 CFR Part11 –compliant
- Manual or Autonomous driving mode



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## UVD Pharma Robot - additional

- CE-marked
- TÜV Rheinland
- Made in Denmark



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## UVD Business case: Production

### COVID-19/pathogen outbreak impact in a Pharma production

When a COVID-19/pathogen outbreak hits the production:

- At least 48 hours lockdown
- 250 employees are sent home
- 4 production lines closed ( 2 shifts a day )

Production Facts

- Average product price 30 EUR€
- Produces 20 pcs/min
- Average salary 25 EUR€ / hour

Impact of employee cost + product loss

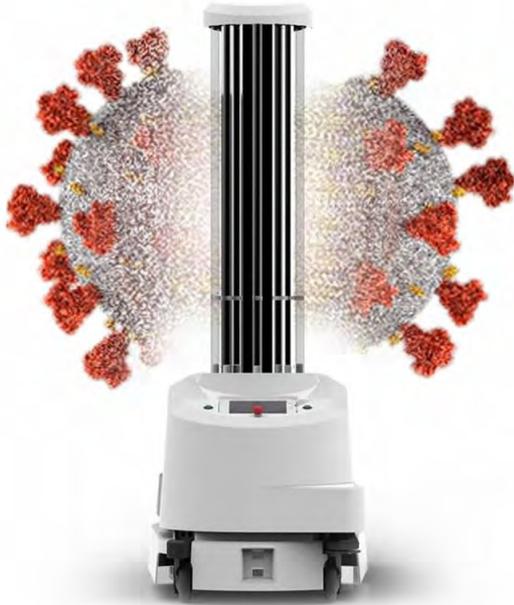
- $1200 \text{ pcs} \times 16 \text{ hours} \times 4 \text{ lines} \times 30 \text{ EUR€} = 2.304.000 \text{ EUR€}$
- $25 \text{ EUR€}/\text{hours} \times 250 \text{ employee} \times 16 \text{ hours} = 100.000 \text{ EUR€}$



The more frequent a disinfection takes place, the more effective the implemented infection prevention measure becomes.

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## UVD Summary



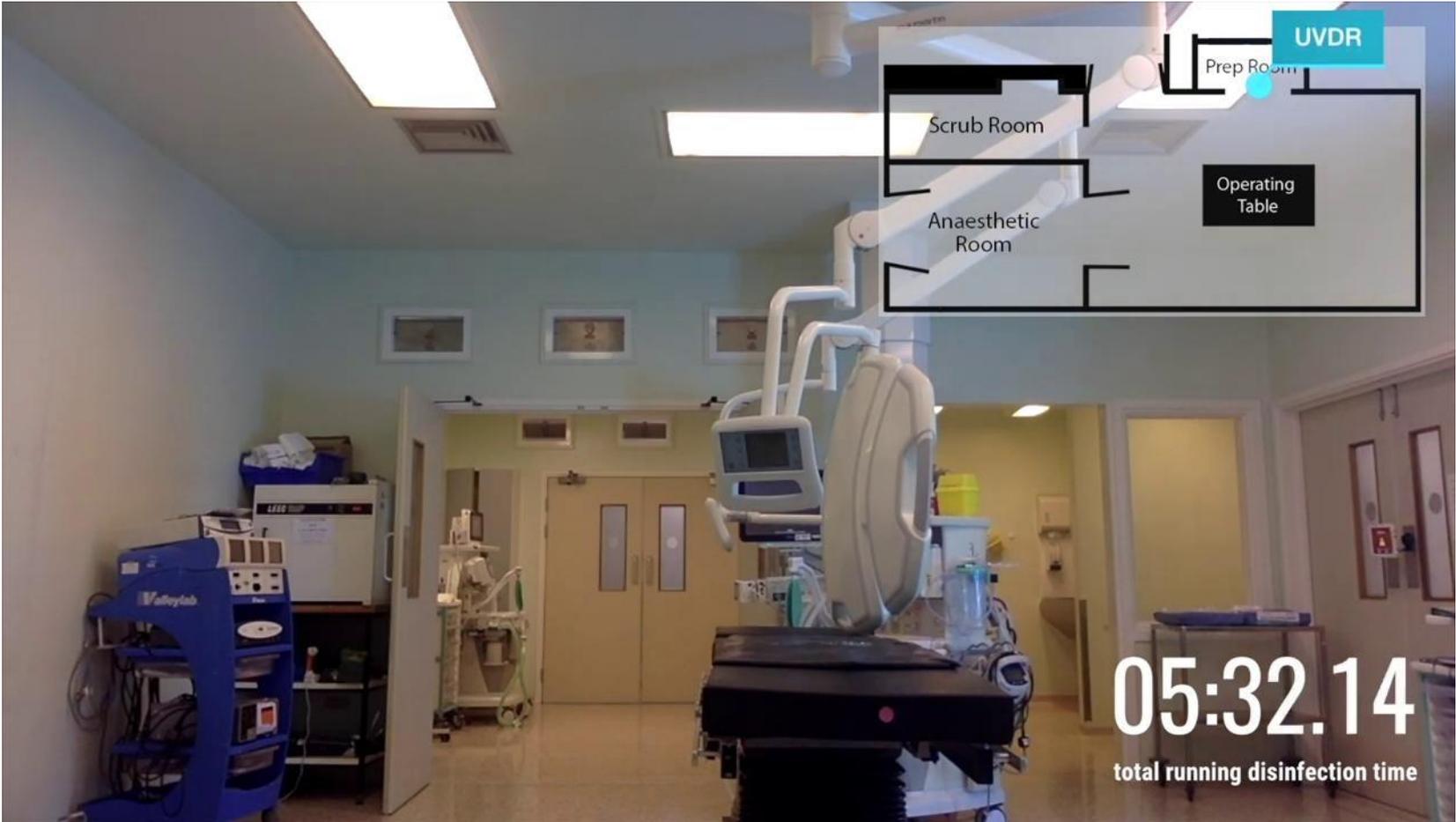
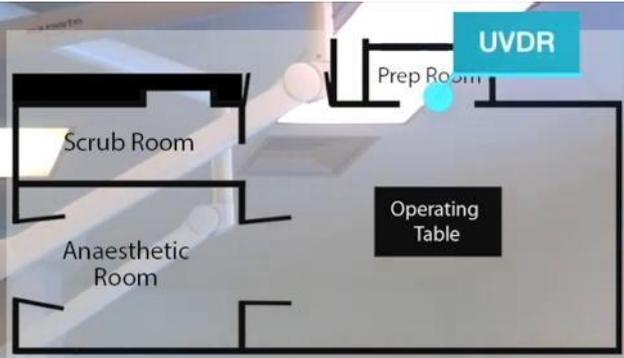
- Fully autonomous, clinically proven infection prevention solution
- Developed for the Pharmaceutical industry – CEA level C/D, further development can be done by customer
- Advanced multilevel safety systems inkl PIR
- Delivers the required dosage to inactivate COVID19 by only driving by, for other pathogens a programmed route - longer exp.
- Validated test reports, FAT/SAT incl, 21 CFR Part 11 compliance,
- IQ, OQ, PQ can be offered as an additional service
- The only disinfection system available, clinically proven to disinfect effectively while 'on the move'
- Secures your production and staff

# UVD ROBOTS

# UVD Contamination Control In The Pharmaceutical Industry

- Recording from an Operating Theater





05:32.14

total running disinfection time

Link to video and UVD Vimeo Channel:  
<https://vimeo.com/386176660>

# Global Overview & Summary

- **By 2050 antibiotic resistance = 10 million deaths globally**
- **.. Cost £66 trillion (ref. NHS)**
- **Employee safety and production optimization key business parameters.**
- **The world needs innovative infection prevention & contamination control solutions.**

## UVD UVD Robots in a nutshell

- A highly mobile, fully autonomous mobile robot platform with integrated UV-C disinfection tower



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- 3rd generation technology with sales to hospitals and non-healthcare facilities in over 70 countries



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- Unrivalled minimal impact to daily work. Requires no manual supervision while disinfecting and no manual work for repositioning



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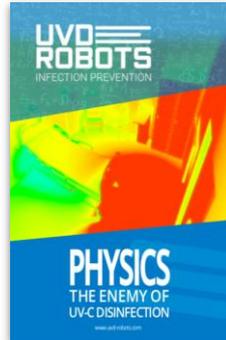
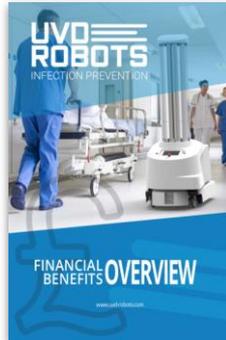
## UVD The UVD Robot in a nutshell

- A highly mobile, fully autonomous mobile robot platform with integrated UV-C disinfection tower
- 3rd generation technology with sales to hospitals and non-healthcare facilities in over 70 countries
- Unrivalled minimal impact to daily work. Requires no manual supervision while disinfecting and no manual work for repositioning
- The only disinfection system available, clinically proven to disinfect effectively while 'on the move'
- Currently the 'Robot of the Year' in the eyes of the International Federation of Robotics



# UVD ROBOTS

## UVD Additional reading material



Physics - The Enemy of UV-C disinfection explains how the UVD Robot addresses the challenges of using UV-C light as a disinfectant

## UVD Global Pharma Launch

- UVD Robots Pharma CEA level C/D approved and validated - ready to order!
- Follow-up email later today from IPA
- 1:1 sessions for further details

**UVD Robots point of contact  
Global Pharma Sales Manager**

Mr. Dane Rönholm  
[dr@ugd-robots.com](mailto:dr@ugd-robots.com)  
+45 6110 1743



## UVD Q&A Session

Questions for the panel, please?



Thank you for taking the time today

We hope we have been able to effectively communicate the comprehensive list of advantages that the world's only, fit for purpose robotic UV-C disinfection will undoubtedly bring to your business, but just in case you would like us to go over a subject again or, if you feel we missed a particular aspect, please use the Q&A functionality or contact us directly.



**THANK YOU**

**UVD**   
**ROBOTS**