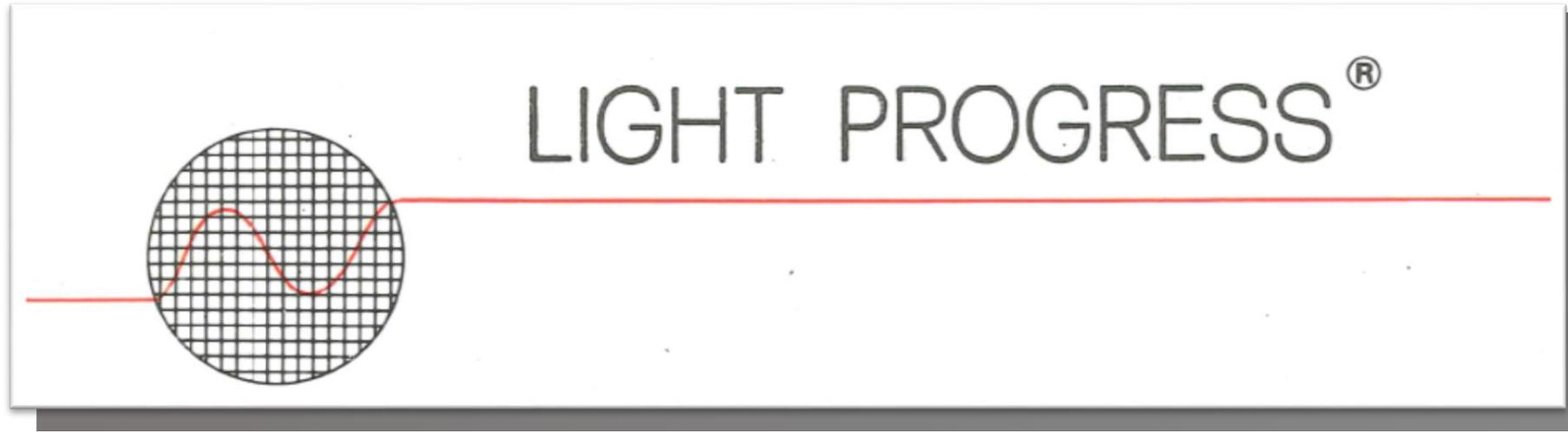


hvac





studies, develops, projects and produces

Ultraviolet Germicidal Irradiation

devices, since

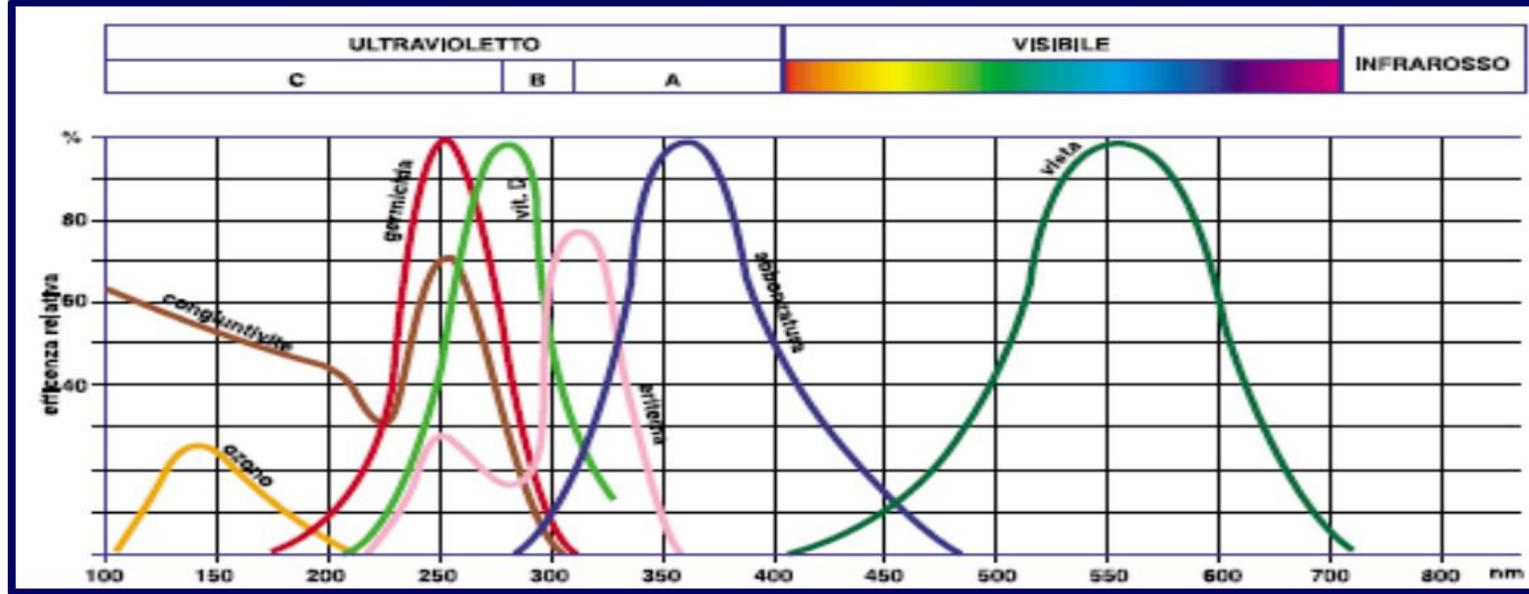


What does UVGI mean?

Light in a broad sense can be divided in visible, infra-red and ultraviolet rays.

Ultra-violet rays (invisible) can be classified in:

- UV - A (with tanning properties)
- UV - B (with therapeutic properties)
- **UV - C (with germicidal properties)**



UV-C (short-wave) from 100 to 280 nm

The absorption of a UV photon by the DNA of microorganisms causes a destruction of a link in the DNA chain, and consequently the inhibition of DNA replication.

The germicidal effects of the UV-C radiation **destroy DNA of Bacteria, Viruses, Spores, Fungi, Moulds and Mites** avoiding their growth and proliferation.

UVGI technology is a physic disinfection method with a **great costs/benefits** ratio, it's ecological, and, unlike chemicals, it works against every microorganisms without creating any resistance.



operates in different fields and turns
Ultraviolet Technology into real
Solutions, providing a Specific Device for
every application needed.



HVAC



Water



Health



Food



Smell reduction

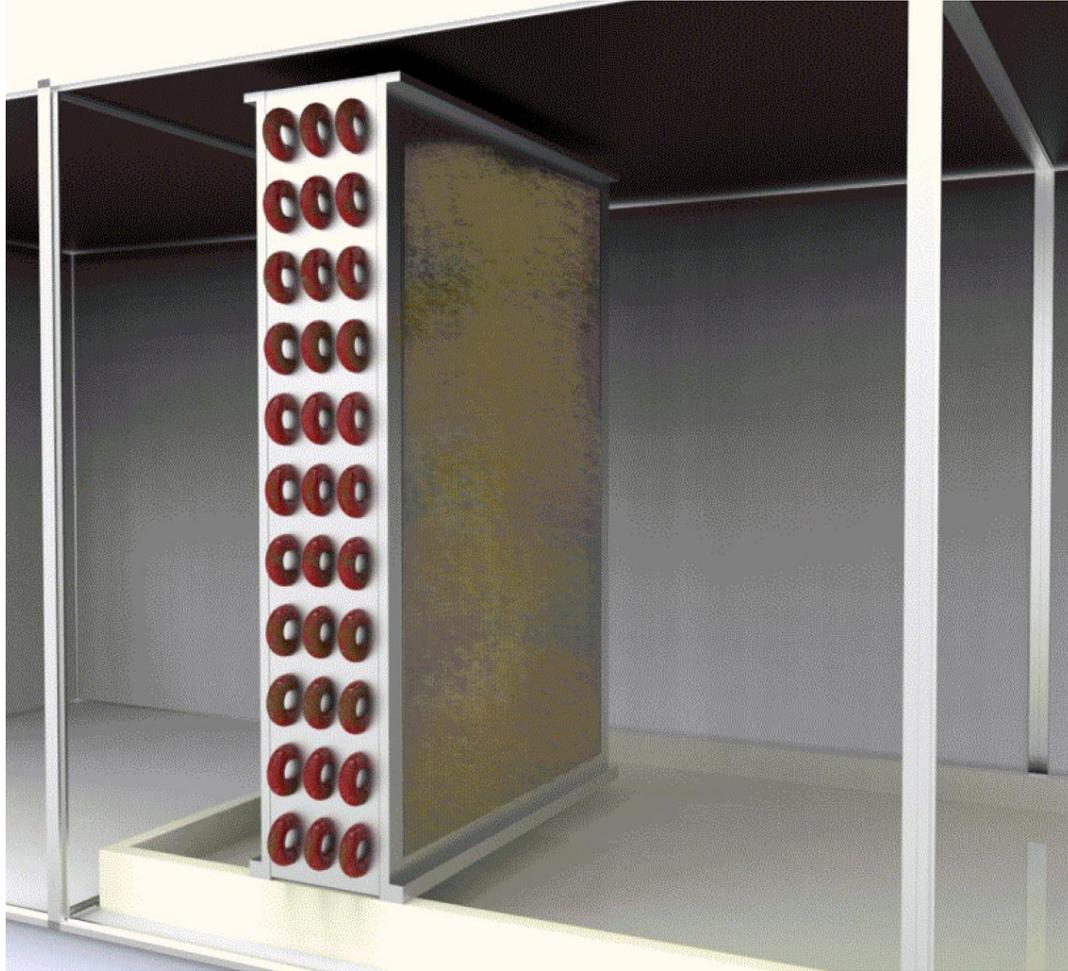


What are most common HVAC issues ?

Air-conditioning systems, and especially the A.H.U. (Air handling unit), are the perfect microcosm for the **growth and distribution of microbial organisms, pathogens, spores, moulds, etc.**



What happens inside HVAC Systems ?



Air recirculation, temperature fluctuations and humidity allow microorganisms to combine with each other in complex ways and settle all over surfaces inside the AC system in the form of an unpleasant **biofilm**.

This biofilm adheres particularly in between the fins of heat exchangers (coils), it settles in water collection tanks and clog the filters in the ducts.

A biofilm less than .5 mm can reduce system efficiency up to 40%.

What happens inside HVAC Systems ?

- ❧ Proliferation of **BACTERIA, VIRUSES, PATHOGENS, SPORES MOULDS**, etc.
- ❧ AC system inner surfaces are covered by an unpleasant **BIOFILM**
- ❧ Coils and filters are **CLOGGED** and lose their efficiency
- ❧ Maintenance interventions with **CHEMICAL** are frequent and necessary

Benefits of using



devices



HEALTH



ECOLOGY



COSTS



**IT ELIMINATES COMPLETELY ALL
PATHOGENS - MICROBIAL LOAD**

Kills Legionella, TBC, viruses, moulds and mites that contaminate HVAC air and surfaces.



**IMPROVES A.H.U. EFFICIENCY,
SAVING ENERGY**

UVGI maintains system clean, keeping inner components' good performances and operation level.



**IT IS ECOLOGICAL, SAFE AND ENSURES
HIGH AIR QUALITY LEVEL**

Even without a persistent and expensive A.H.U. cleaning intervention schedule.



NO CHEMICALS!

UVGI is a physical method that restrains the use of chemical cleaning products, useful credit for LEED CERTIFICATION Indoor Environmental quality (Green Building Council).



YOU CAN USE IT EVERYWHERE!

Healthcare, Food Industries, Commercials, Hotel and Restaurants, Public Transportation, Airports, Schools and Universities, but also Residential and Private Buildings.



EASY-TO FIT, YOU CAN TRUST ON US!

Our Team sizes and projects the most suitable layout for your needs with a specific software. Our devices are adaptable and easy to apply.

What are  LIGHT *PROGRESS* devices

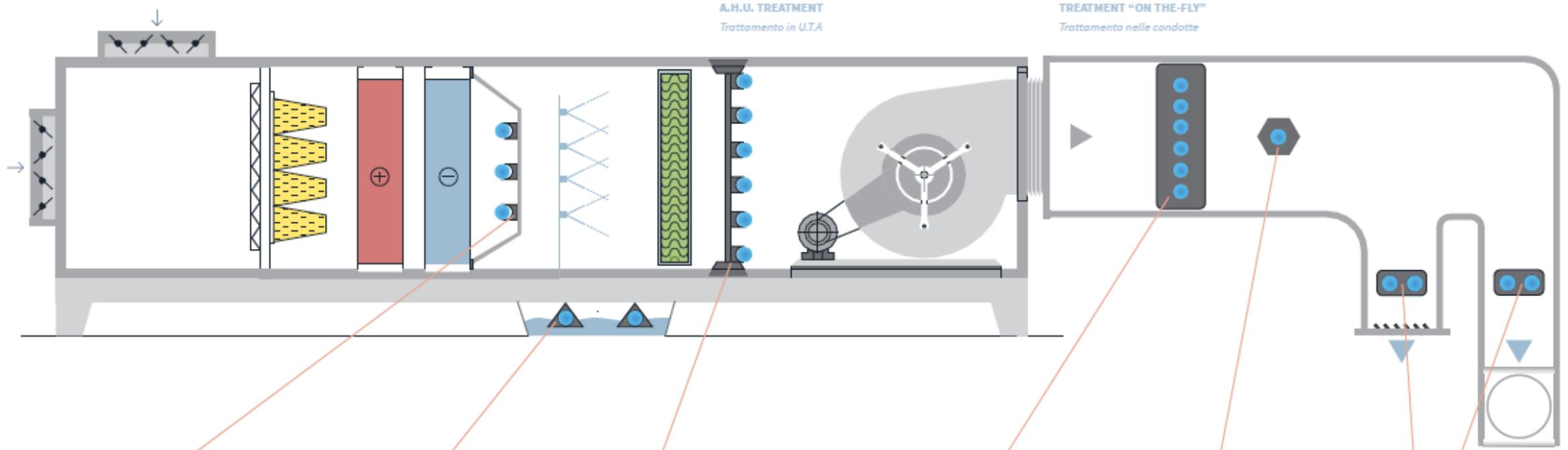
designed to improve

Indoor Air Quality

and comfort ?



Application Scheme



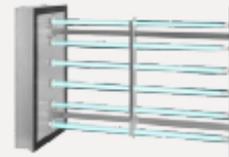
1. UV-STICK-SCR / UV-STICK-SCR-UL



3. UV-STYLO-E / UV-STYLO-E-UL



4. UV-DUCT-SQ / UV-DUCT-SQ-UL



2. UV-RACK / UV-RACK-UL



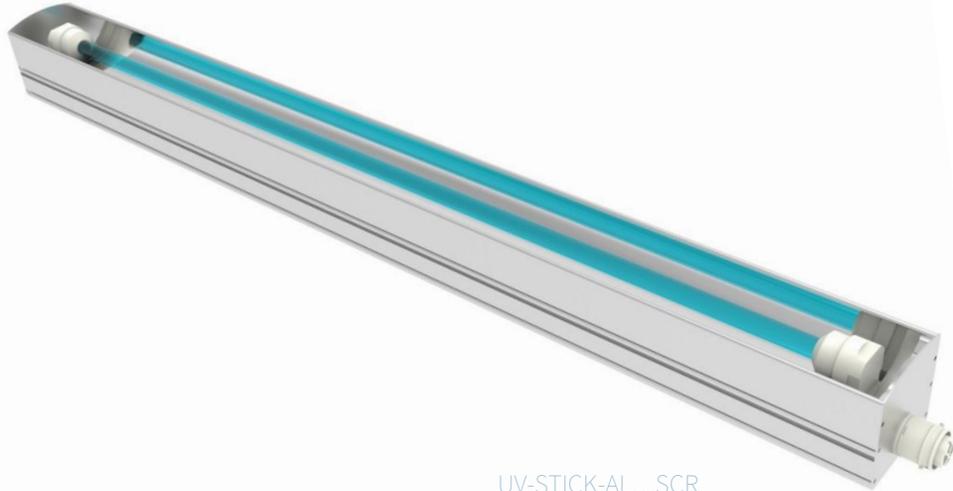
5. UV-STYLO-X / UV-STYLO-X-UL



6. UV-DUCT-FL



UV-STICK-SCR



UV-STICK-AL...SCR
Aluminum



UV-STICK-NX...SCR
Stainless Steel

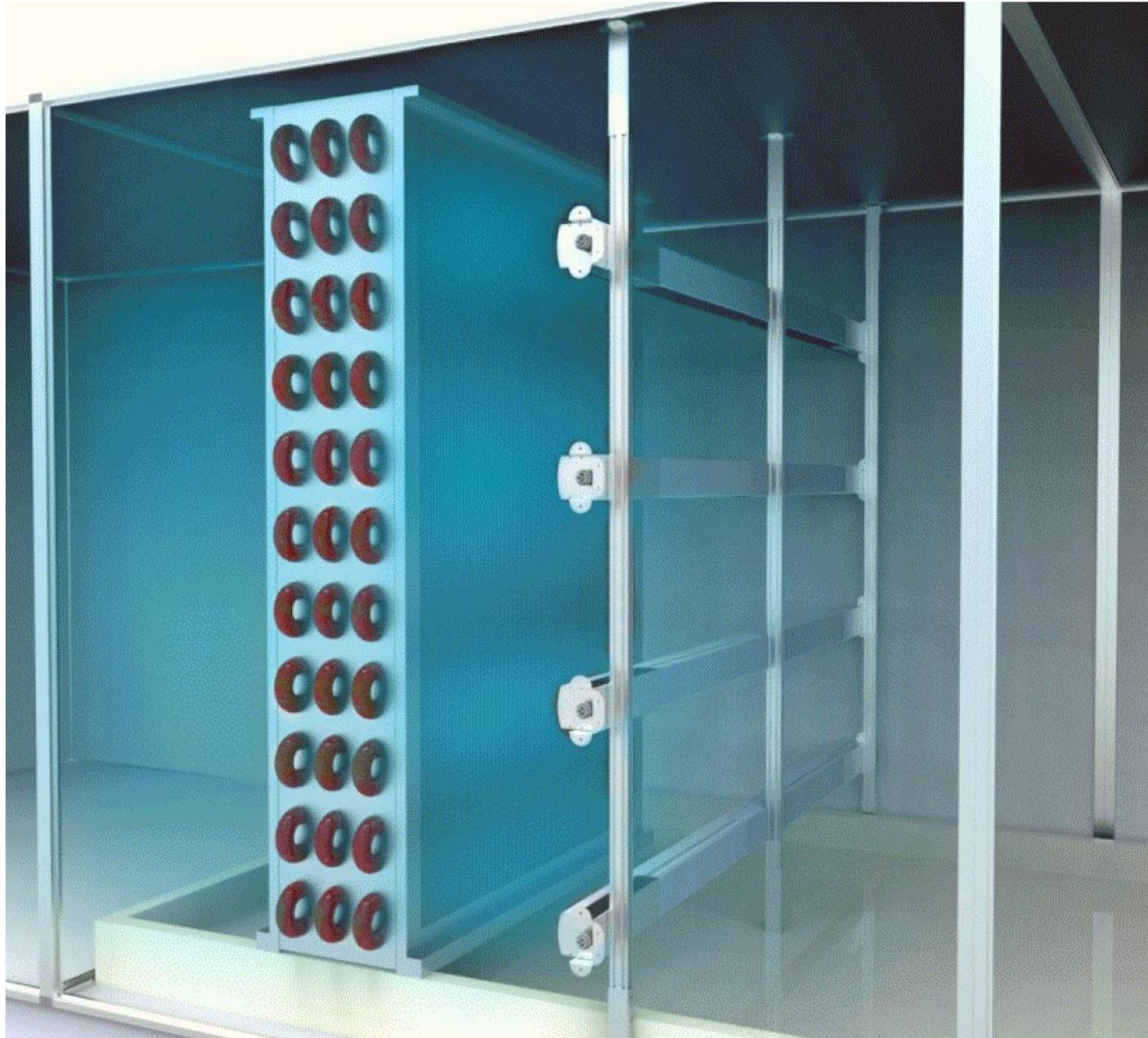
Specific for Coils treatment, it avoids settling and proliferation of Biofilm on the surfaces.

Special mirror bright reflector to increase UVGI power.

Available in SS or Aluminum.

Ballast on-board.





UV-STICK-SCR

Mounting kit is provided to fit every AHU, UV-STICK-SCR is very flexible and easy to apply, the serial connection of more than 10 devices allows you to switch ON all the systems, through 1 single power supply cable.

Signals and alarms can be checked on a control board.

N° COLUMN Width (inside AHU) ROWS Nr Height (inside AHU)	1 From 650 to 2000 mm	2 From 1500 to 3700 mm	3 From 3000 to 5300 mm
A From 400 to 1000 mm			
B From 1000 to 2000 mm			
C From a 2000 to 3000 mm			
D From 3000 to 4000 mm			

We designed 6 different application layouts to fit all common AHU sizes.

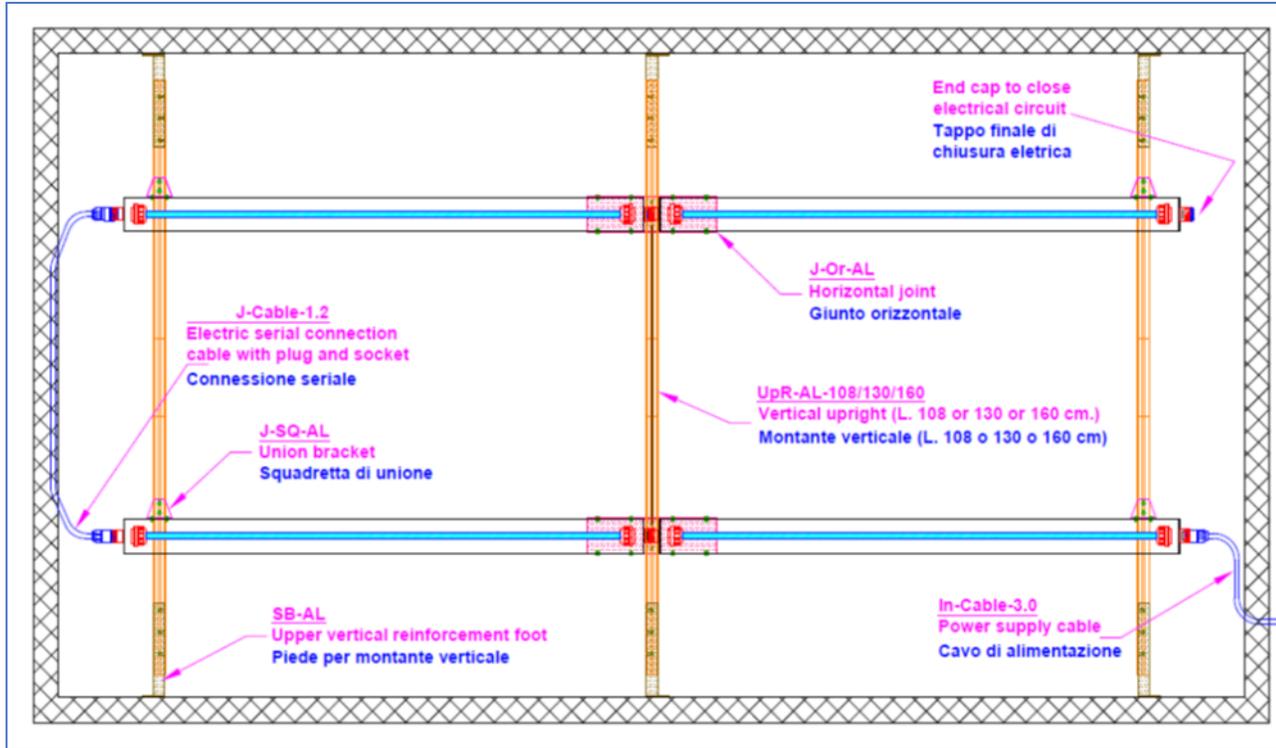
These solutions include also the mounting kit to install the devices on AHU walls;

The 6 different kits have two options to link the systems to AHU's walls:

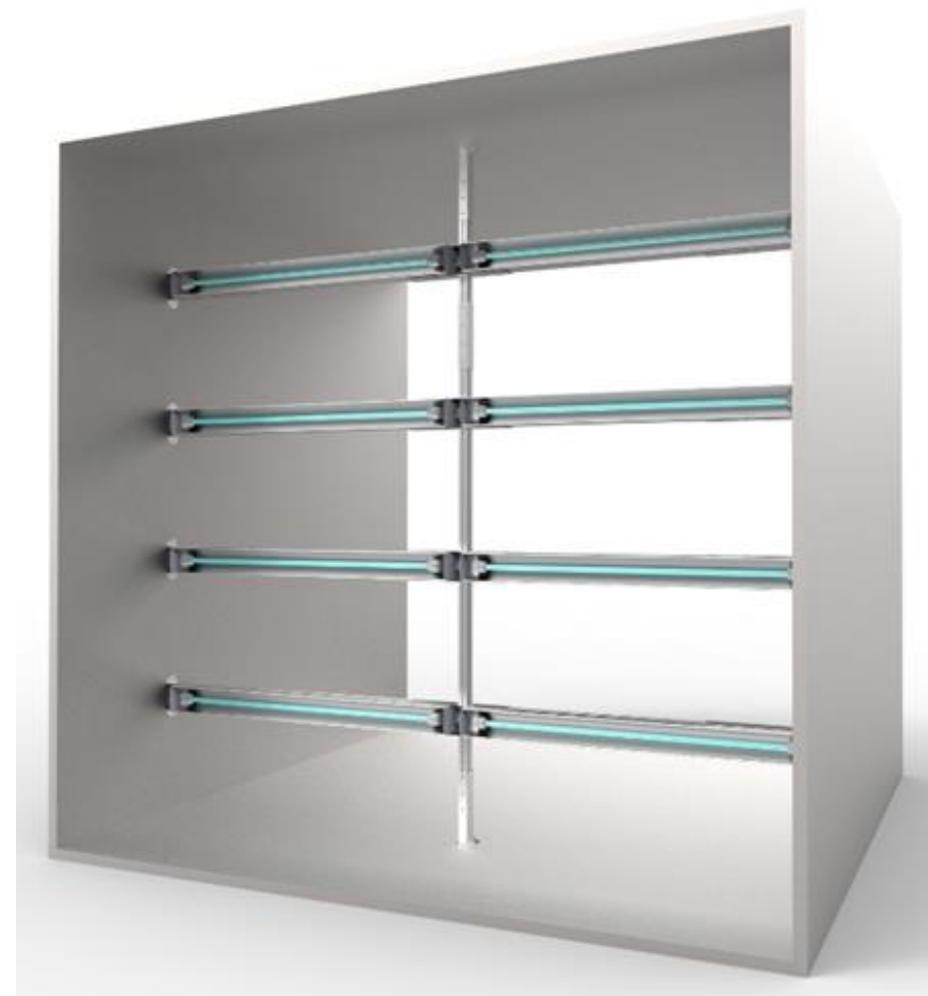
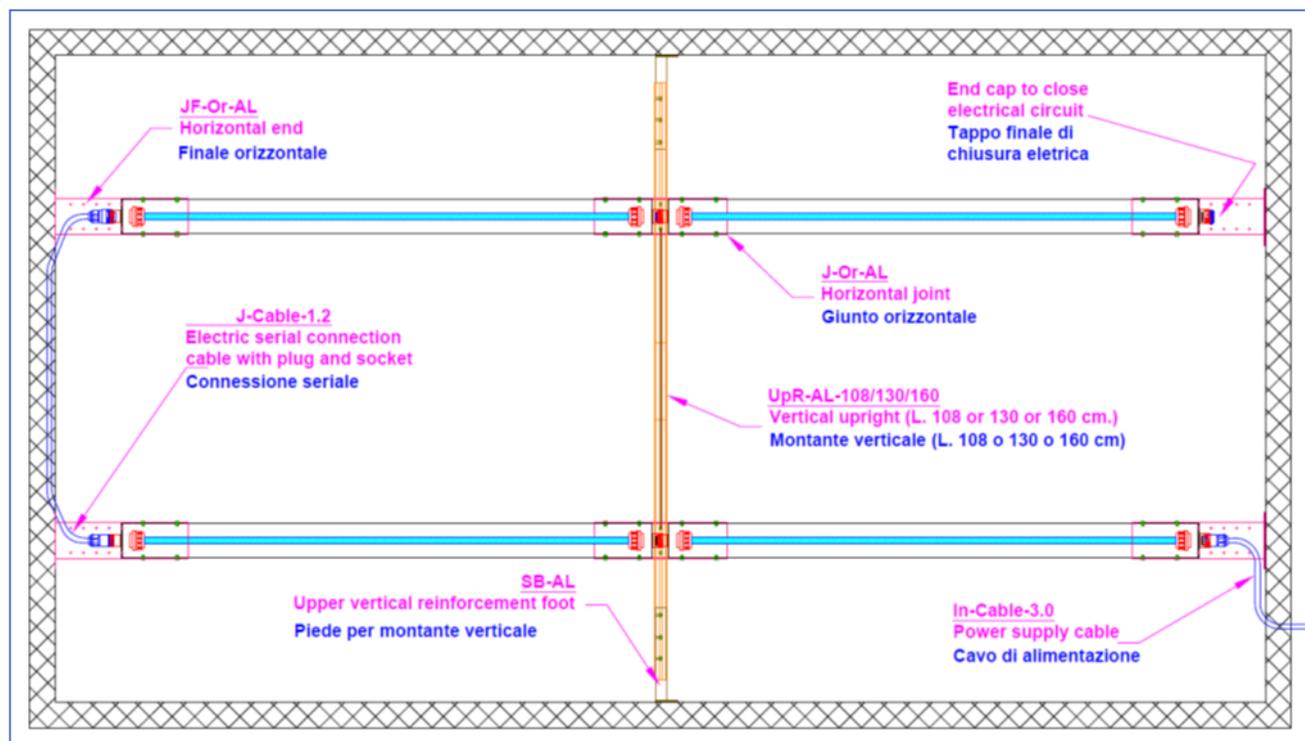


-V version = include only vertical frames (uprights).

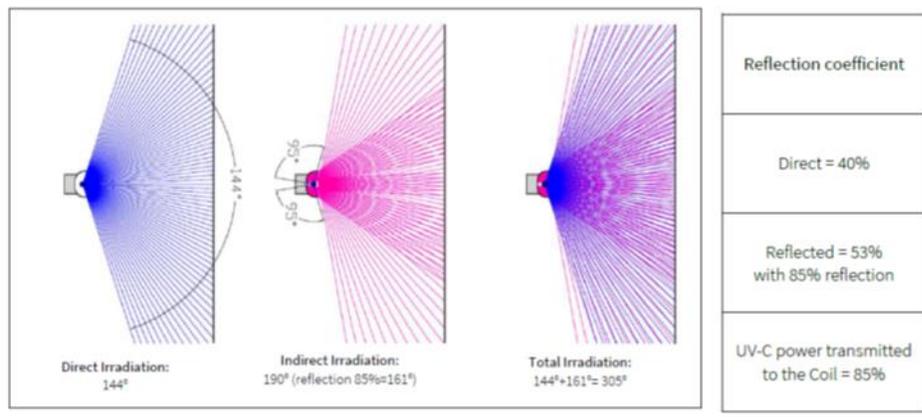
It is easier to apply; devices are linked inside the AHU only on AHUs' floor and ceiling.



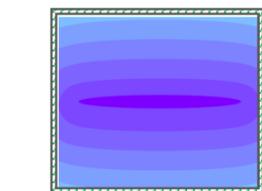
-H version = mounting kit include both horizontal and vertical links.
 This solution provide less pieces, but the fixing phases could be more complicated,
 (especially in small AHUs);



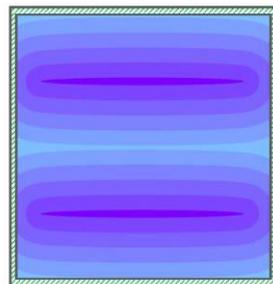
Reduction 99%		
	Aspergillus N.	Legionella Pn.
1	6 min.	12 s
2	7 min.	14 s
3	8 min.	16 s
4	9 min.	18 s
5	10 min.	20 s
6	11 min.	22 s
7	12 min.	24 s
8	13 min.	26 s



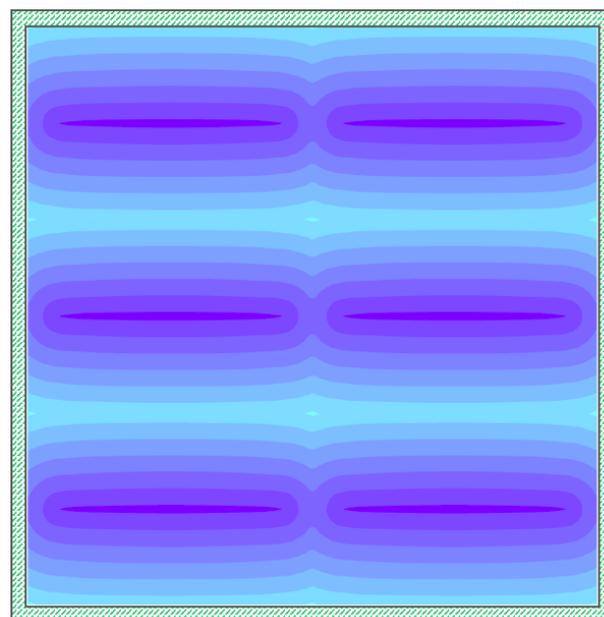
IRRADIATION MAP: this simple schema show you the distribution and intensity of UV-C rays toward the coil, even though you can reach 99% of microbial load reduction within seconds/minutes, always remember that UV light has to be always turned ON while Air Conditioning System is working!



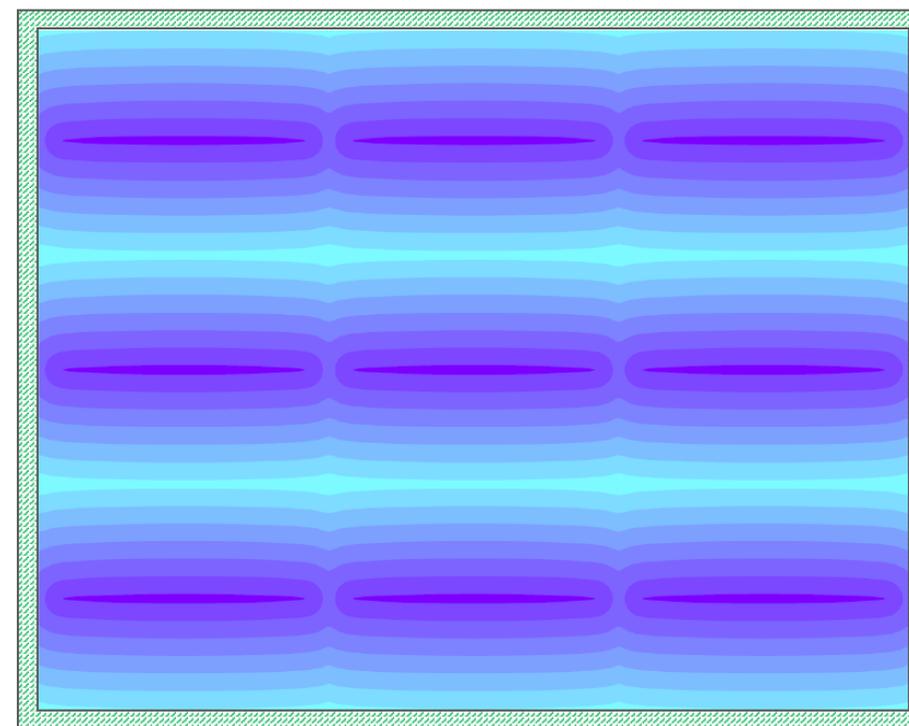
A 1



B 1

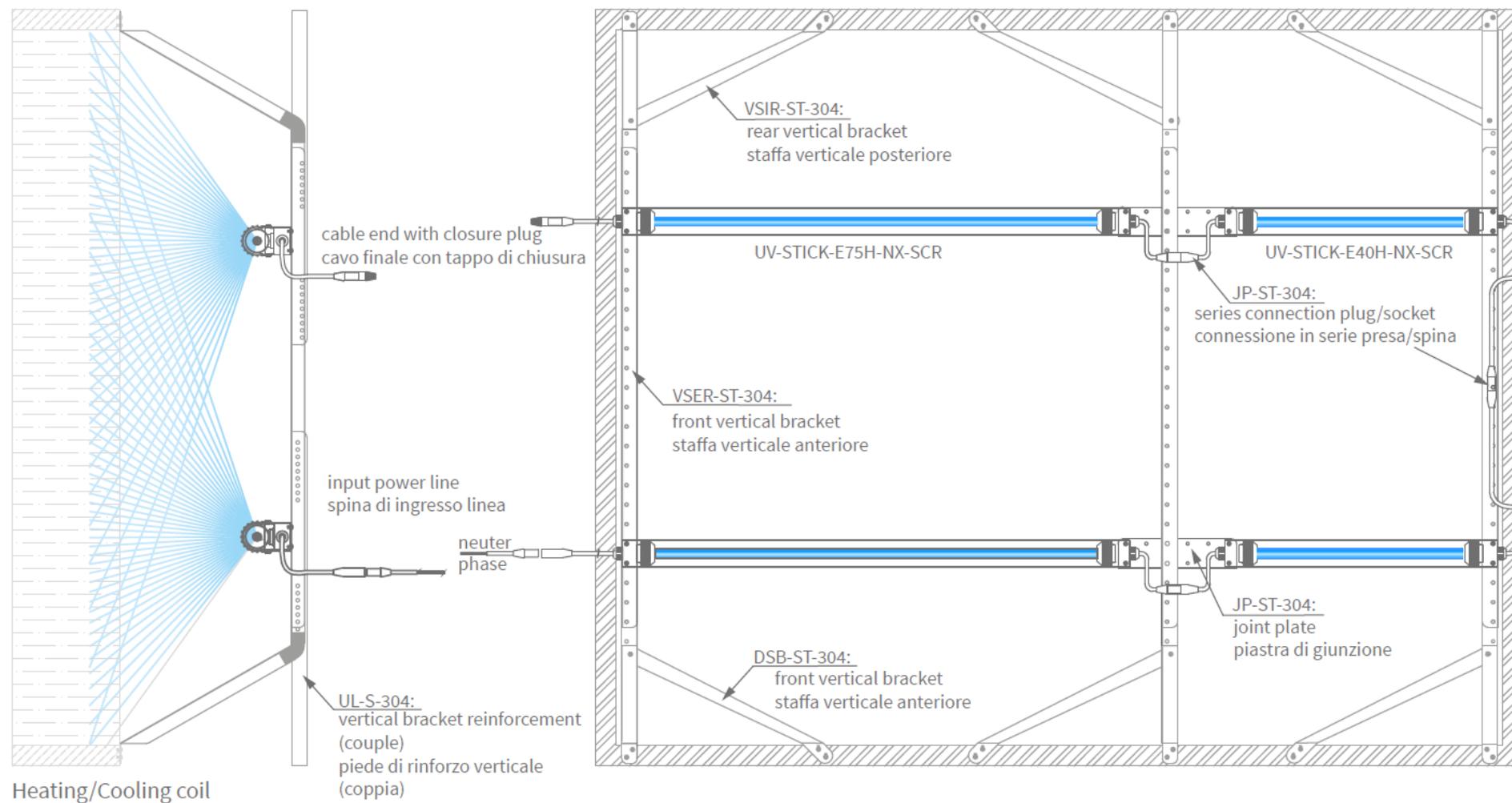


C 2



D 3

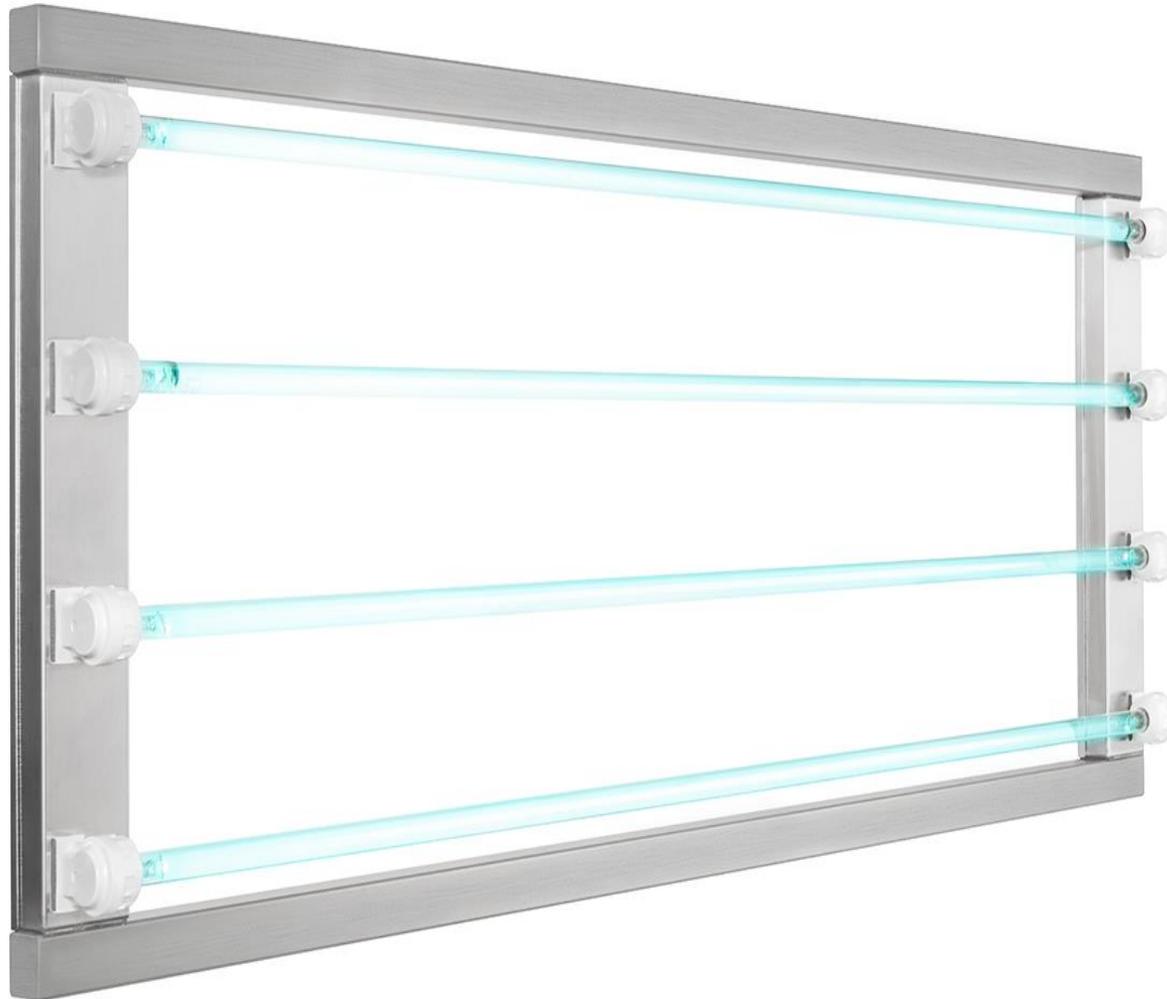
INSTALLATION LAYOUT: it is possible to apply our systems also linking them directly on the coil surface, in this way you can be sure that the distance between coil and UV-C lamp is fixed at 25 cm c.a. (only for UV-STICK-NX-SCR)



	STERIL-AIRE	SANUVOX	 LIGHT PROGRESS
EMISSION LEVEL			
BUILT-IN POWER SUPPLY			
BI-PIN lamp			
AERODYNAMIC REFLECTOR			
MIRROR BRIGHT REFLECTOR			
MAP-PATHOGEN-TIME			
IP55 PROTECTION			
UL CERTIFICATE			
ready-to-plug SERIAL CONNECTORS			
A.H.U. WALLS FIXTURE			
A.H.U. COIL FIXTURE			
IN-DUCT INSTALLATION PARALLEL TO AIR FLOW			
IN-DUCT INSTALLATION PERPENDICULAR TO AIRFLOW			



UV-DUCT-SQ



Square-grid device, it fits everywhere because its sizes are the same as common filters .



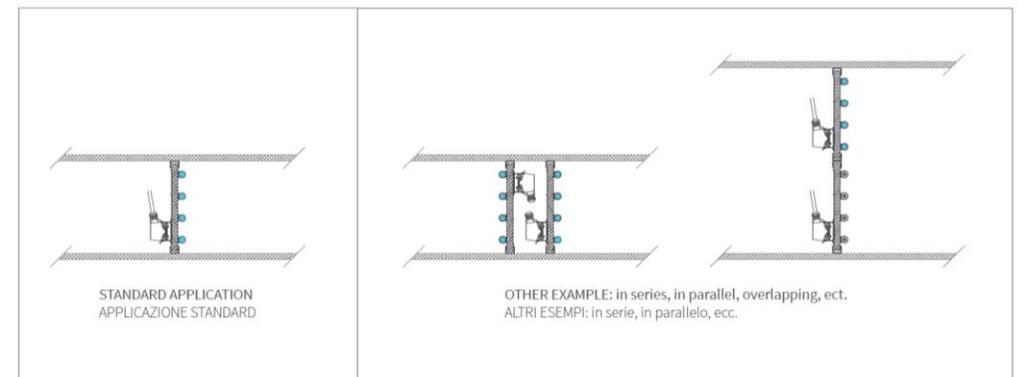
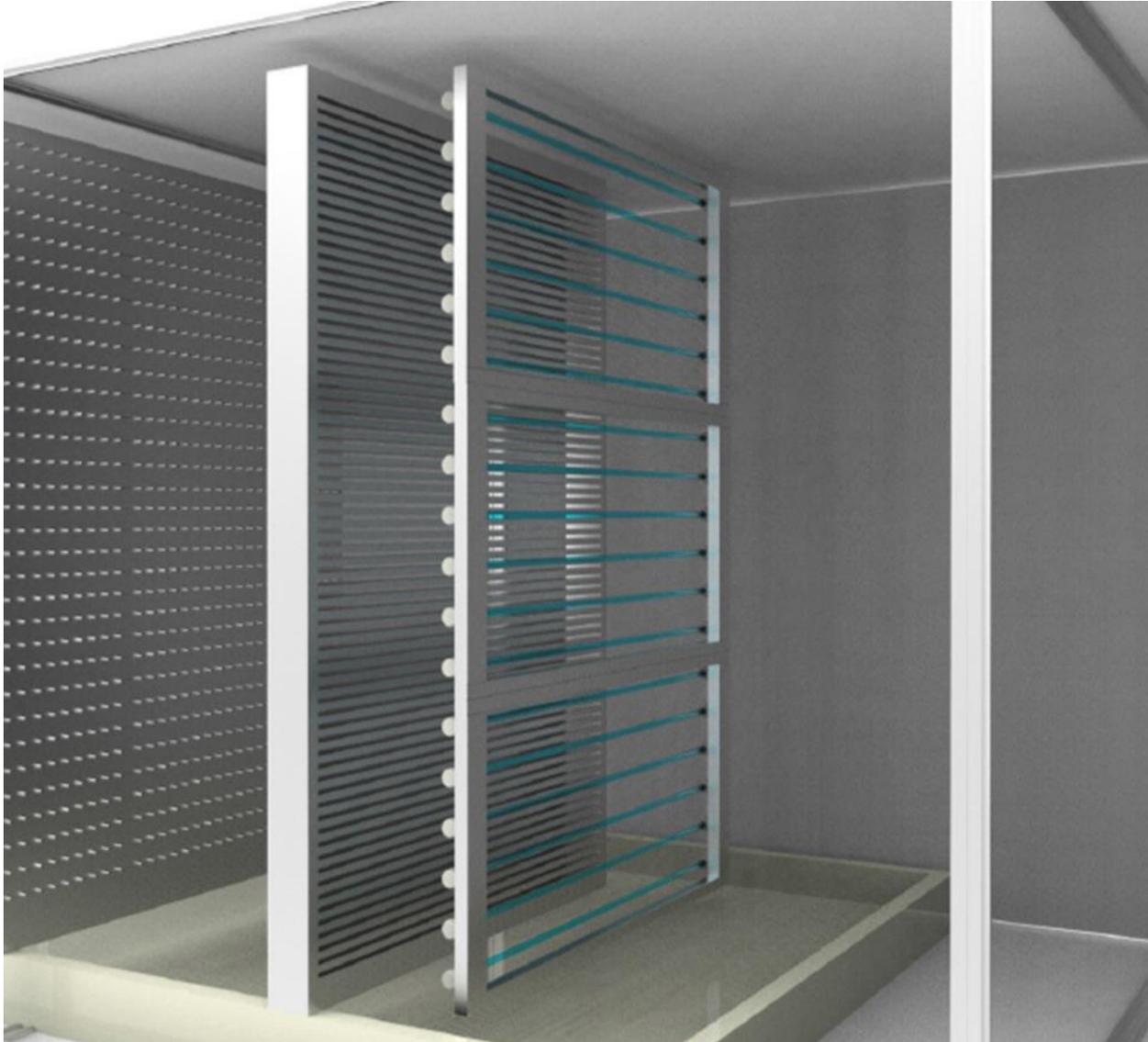
Signals and alarms can be checked on the control board, where ballast is also located.

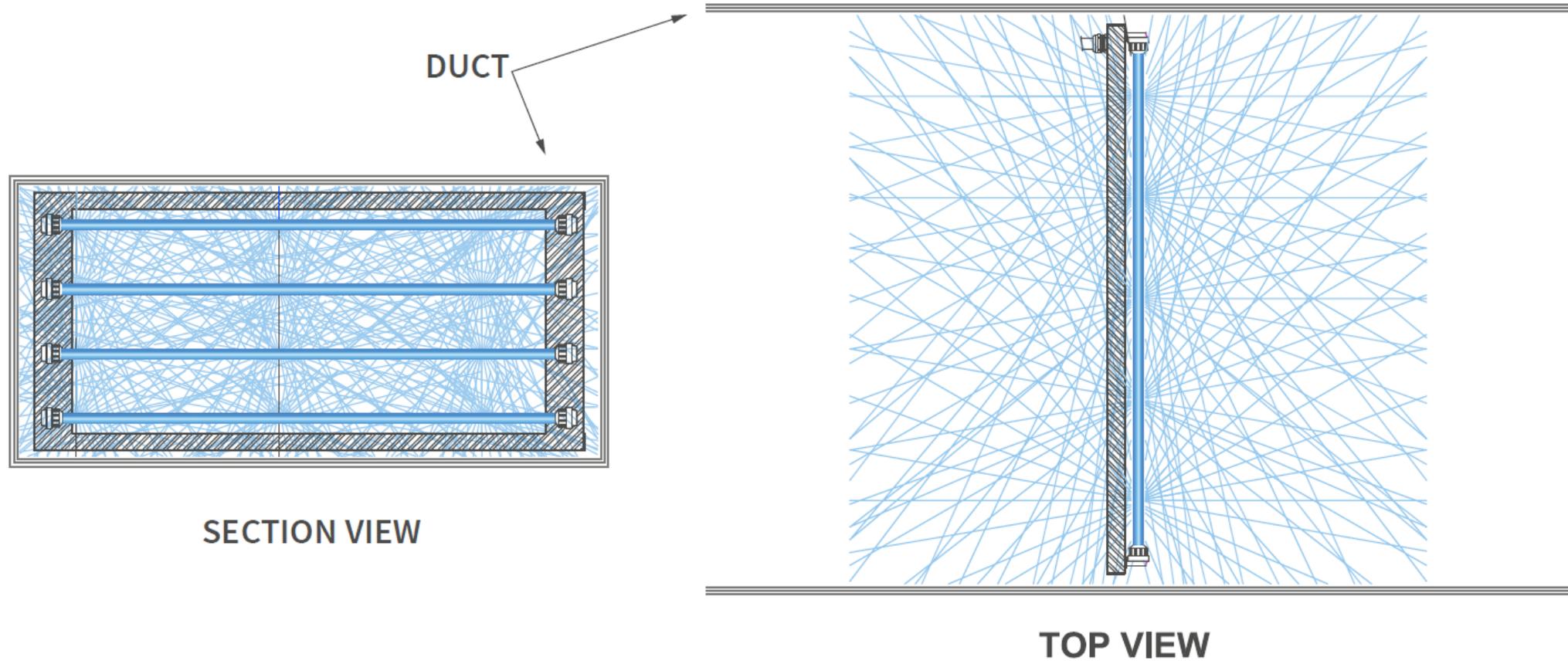




UV-DUCT-SQ

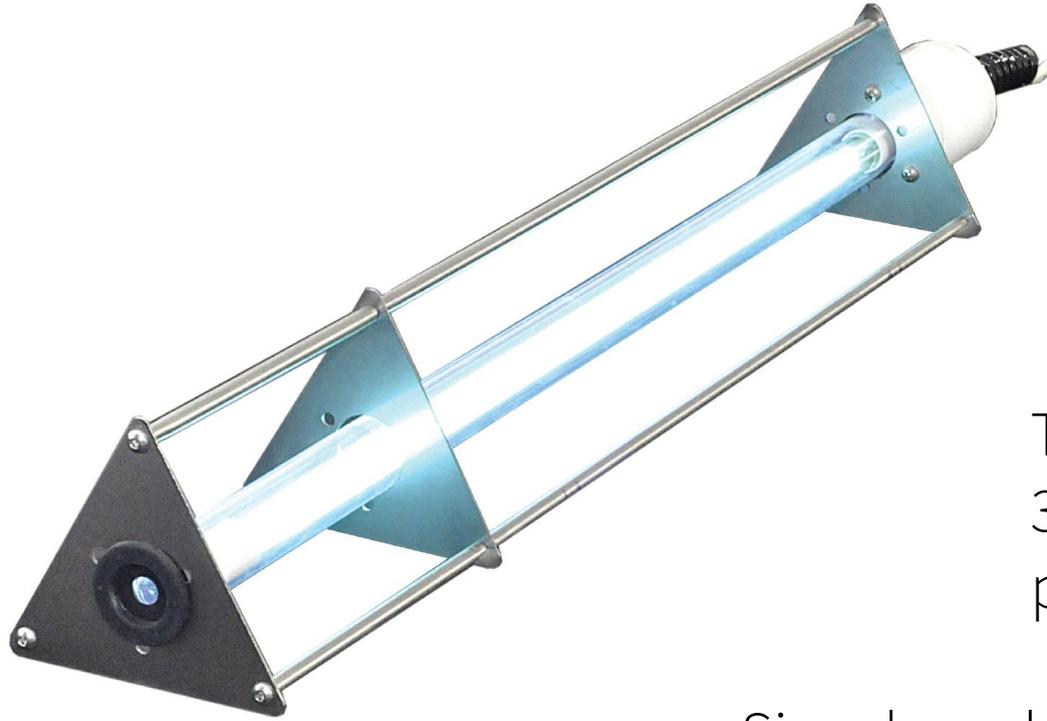
UV-DUCT-SQ has been designed to adapt to different sizes and ducts sections, placing one device to cover the surface or matching more devices together side-by-side, one on the other (overlapping), in series, etc. using scroll-in “U” profile, like filters.







UV-STYLO-E

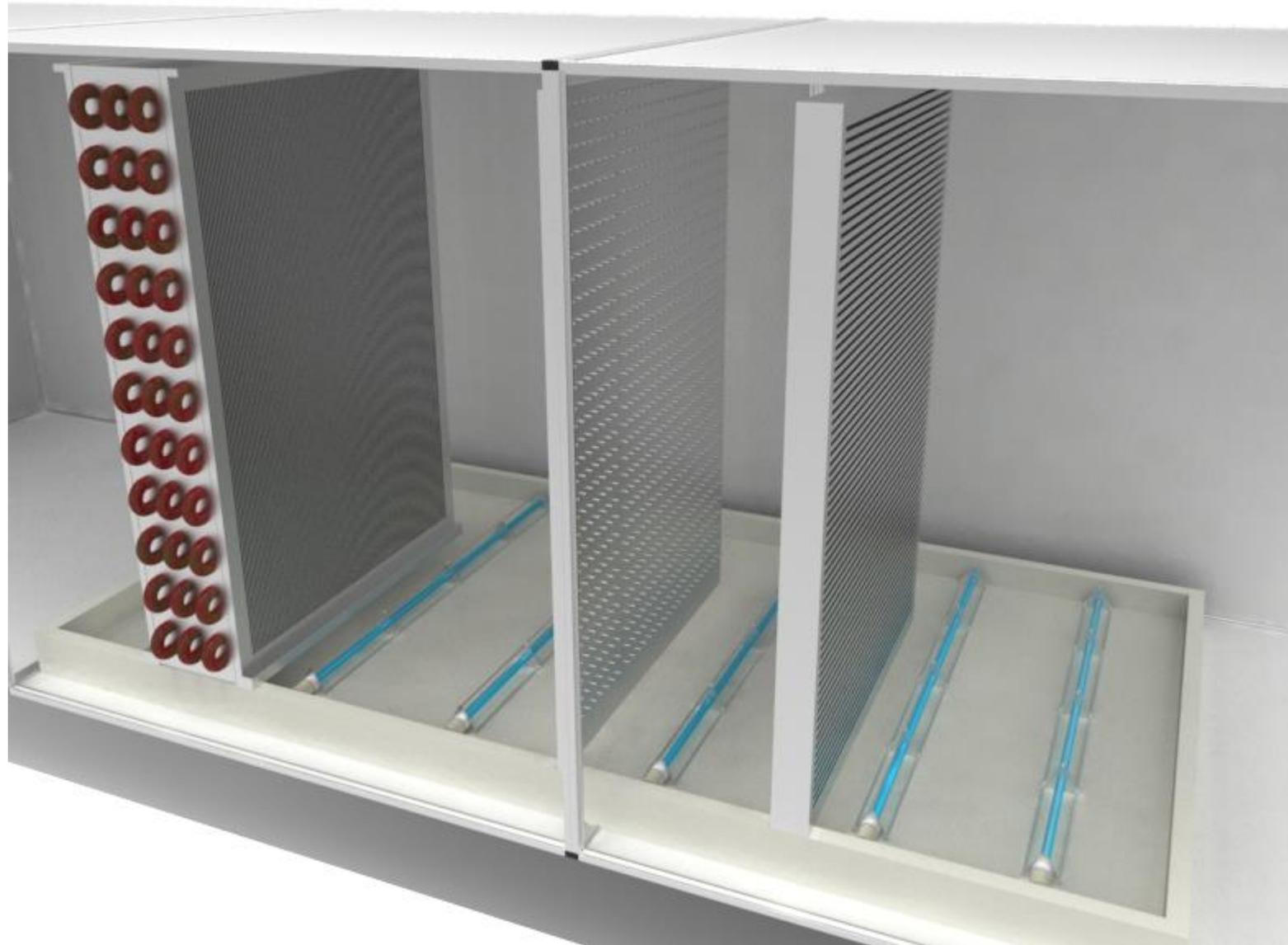


Installed inside the humidifier collection tanks submerging the device (up to 10 m) or under water splashes.

Triangular frame in stainless steel AISI 304 in which is housed a UV-C lamp protected by a pure quartz sleeve.

Signals and alarms can be checked on the control board, where ballast is also located.





UV-STYLO-E

Water sprayed inside AC system spreads airborne diseases inside buildings, through infectious particles breathable in air, some of them are very dangerous and lethal, such as *Legionella*, *Pneumophila* and *TBC*.



UV-RACK



Designed for in-duct air treatment, it may be applied inside final AHU portion to sanitize surfaces, too.

Adjustable feet to fit duct sizes

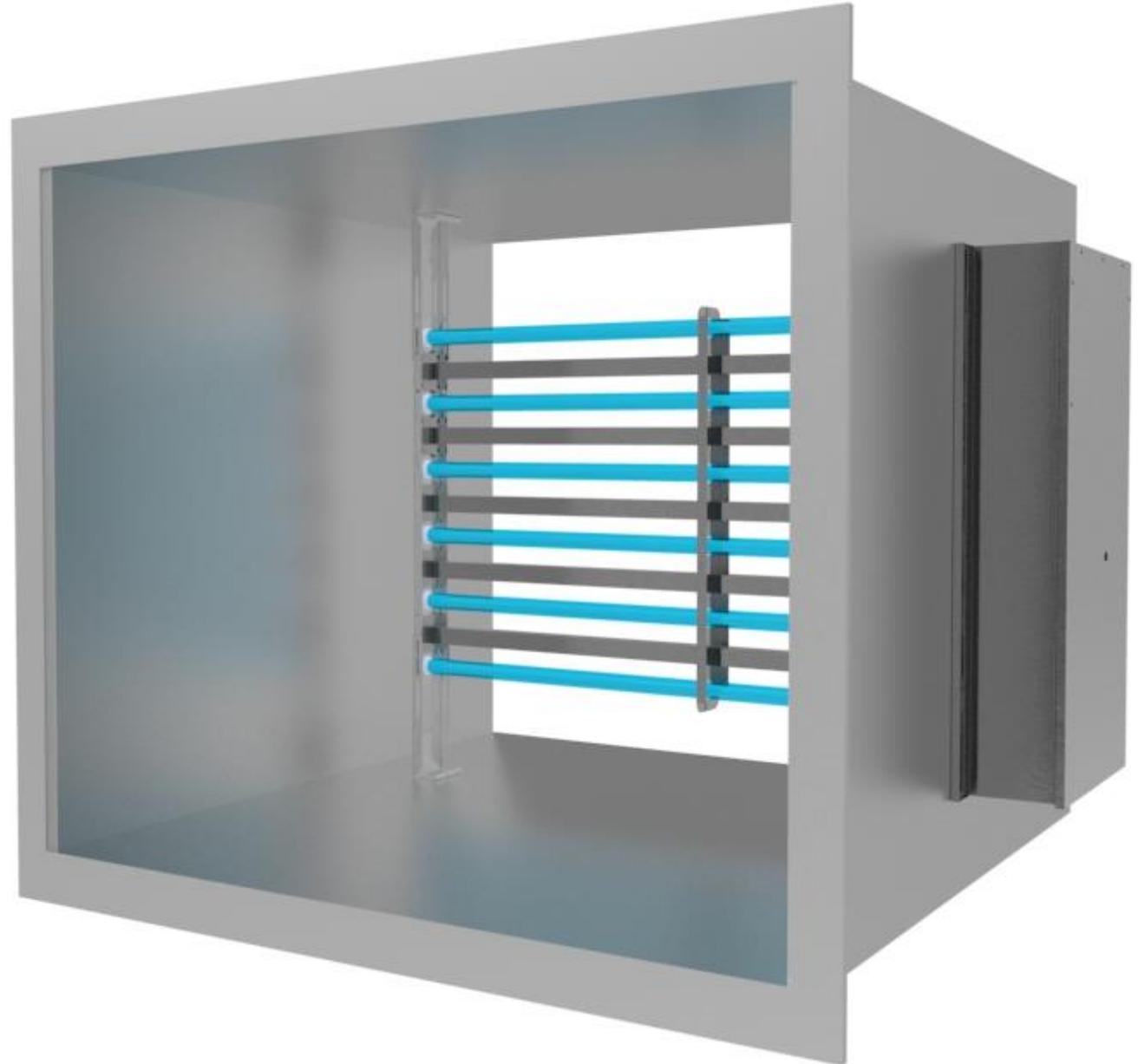
Ballast on-board.





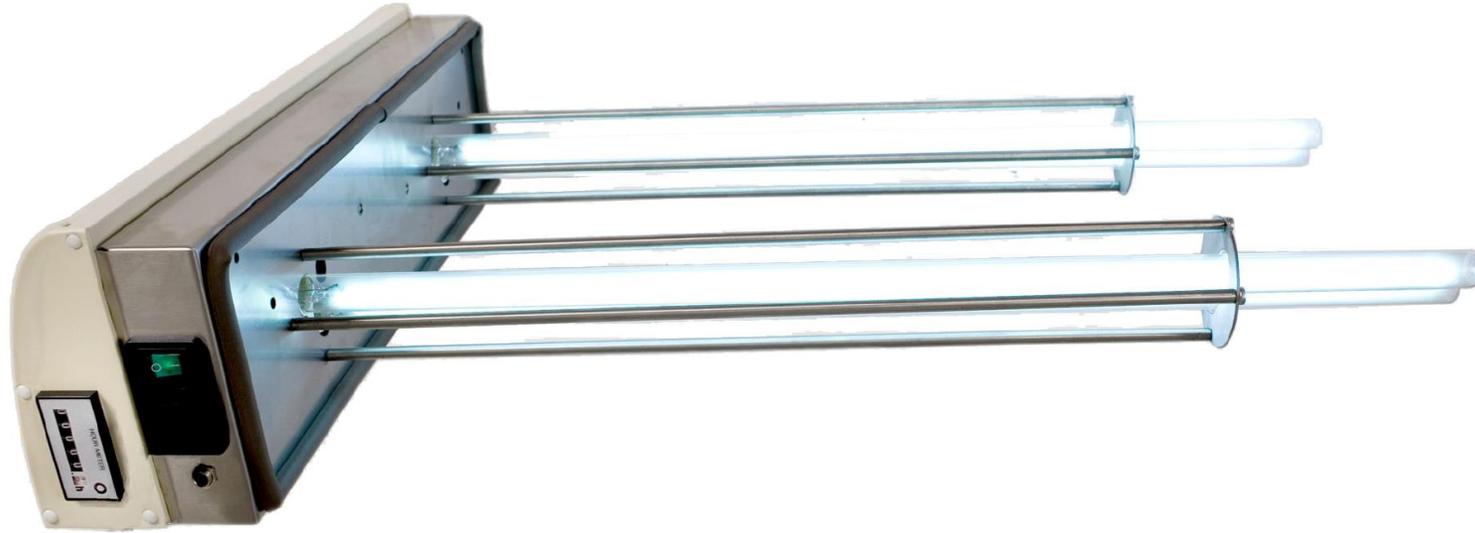
UV-RACK

UV-RACK has been designed to adapt to different sizes and ducts sections, it is very compact, and its installation requires just a few simple steps: insert the lamps within the air duct through a cut and screw UV-RACK case on the external channel wall, and you're done!





UV-DUCT-FL

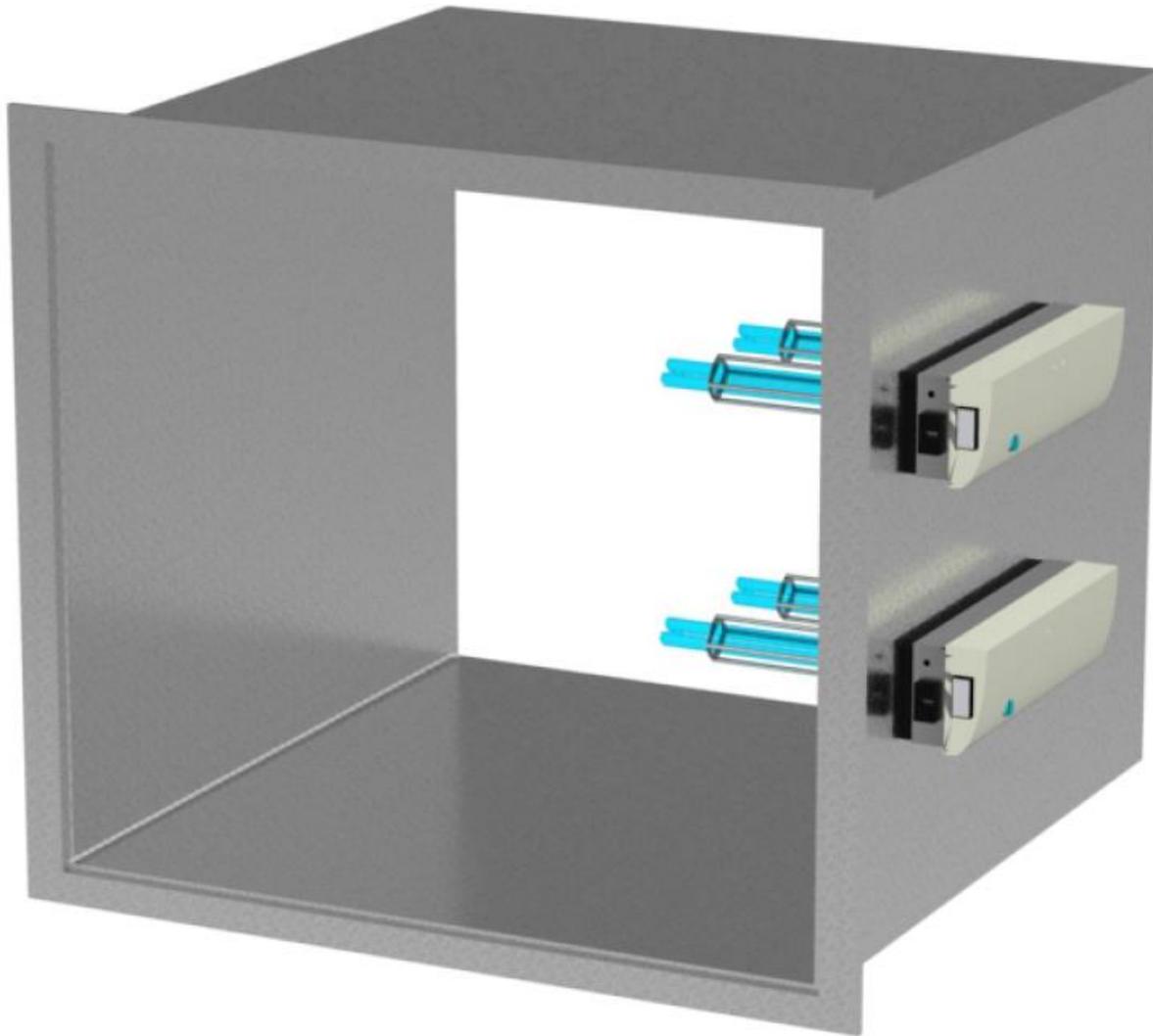


Designed for in-duct air treatment, it can be applied inside final AHU portion to sanitize surfaces, too.

Fits in small spaces, even for retrofit applications.

Ballast on-board.





UV-DUCT-FL

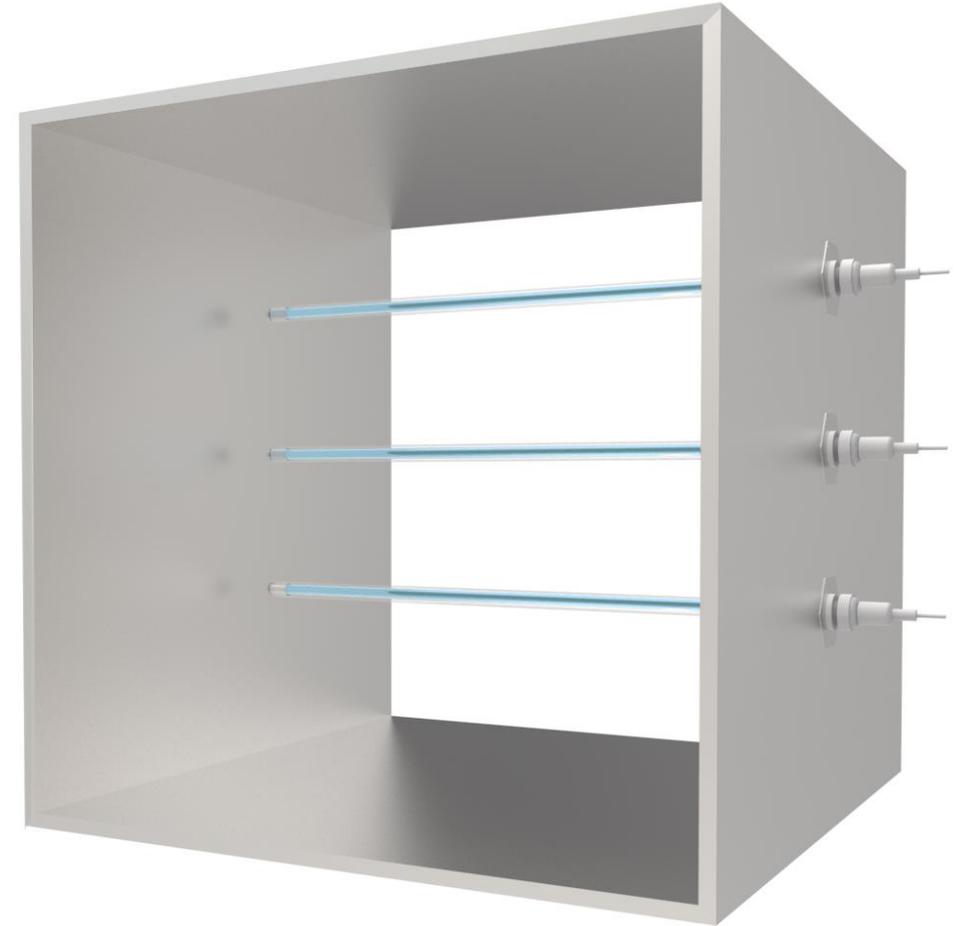
Its installation requires just a few simple steps: insert the lamps within the air duct through two holes and screw UV-DUCT-FL flange on the external channel wall, and you're done!

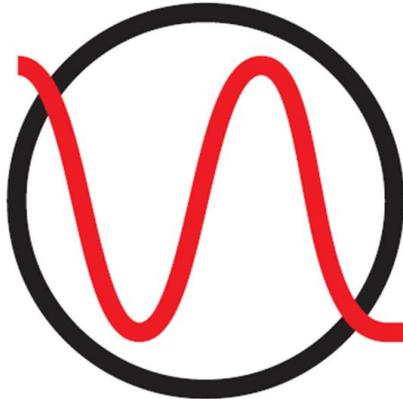


UV-STYLO-X serie includes a choice of different models designed for the application in very narrow spaces. The device consists of an hexagonal flange in stainless steel AISI 304 in which is housed a UV-C lamp protected by a pure quartz sleeve.

 UV-STYLO-X

UV-STYLO-X can be installed in tiny spaces, just making a hole directly on the wall where you want to apply the UV-C irradiation, as for example on the side of a duct. Then you need to insert the unit through the hole made and screw the AISI 304 stainless steel flange with three screws. 360° irradiation accomplished!





LIGHT *PROGRESS*

Certificates

Best Practice Compliance



HVAC



Water



Health



Food



Smell reduction

Certificates



LIGHT PROGRESS

CE

DECLARATION OF COMPLIANCE

We, LIGHT PROGRESS S.r.l., hereby declare under our own responsibility that the following units of own production:

[Redacted]

⇒are in accordance with EEC directive 2014/30/EU (Electromagnetic Compatibility)
 ⇒are in accordance with EEC Machinery Directive dispositions 2006/42/EU
 ⇒are in accordance with EEC Low Voltage Directive 2014/35/EU
 ⇒are in accordance with EEC (RoHS) directive 2002/95/EU and 2011/65/EU

TECHNICAL STANDARDS APPLIED

UNI EN ISO 12100:2010 Safety of Machinery - Basic Concepts, General Principles for Design - Risk assessment and risk reduction
UNI EN ISO 13857:2008 Safety of Machinery - Safety Distances to prevent danger zones being reached by the upper and lower limbs (2008)
ISO 14120:2015 Safety of Machinery - Guards - General Requirements for the Design and construction of fixed and movable guards
UNI EN ISO 13849-1:2016 Safety of Machinery - Parts of the Control System related to the Safety - Part 1: General Design Principles
UNI EN ISO 14119:2013 Safety of Machinery - Interlocking devices associated with guards - Principles for design and selection
CEI EN 60204-1/EC Safety of Machinery - Electrical Equipment of Machines. Part 1: General Rules (2010)
EN 61439-1:2011 Low-voltage Switchgear and Control Gear Assemblies. Part 1: General rules

FURTHER TECHNICAL STANDARDS APPLIED:

IEC EN 60335-1 "Safety of household electrical appliances and similar"
 Electronic Ballasts for the control of the lamps in accordance with the standard EN 60928.
 Germicidal UV-C Lamps in accordance with EN 61199.
 Electrical Protective Measures in accordance with IEC 70-1, EN 60229.

Anghiari, 05 January 2017

LIGHT PROGRESS

Responsible for Standards: Dr. Aldo Santi

LIGHT PROGRESS S.r.l. Via G. Marconi, 81 - 53031 ANGIARI (AR) - ITALY - <http://www.lightprogress.com>

Jan-2017 Pag. 22/24

kiwa
Partner for progress

Reg. Number	6950 - A	Valid From	2016-07-26
First issue date	2007-12-21	Last modification date	2013-07-24
Following renewal date	2019-07-29	EA Sector	EA: 19

Quality Management System Certificate
ISO 9001:2015

We certify that the Quality Management System of the Organization:
LIGHT PROGRESS S.r.l.
 Is in compliance with the standard UNI EN ISO 9001:2015 for the following products/services:
 Design and production of UV-C rays disinfection systems

Chief Operating Officer
 Giampiero Belcredi

Maintenance of the certification is subject to annual survey and dependent upon the observance of Kiwa Cermet Italia contractual requirements.

This certificate consists of 1 page.

LIGHT PROGRESS S.r.l.
Registered Headquarters
 - Via Guglielmo Marconi, 81 52031 Anghiari (AR) Italia
Certified sites
 - Località San Antonino 40 52043 Castiglion Fiorentino (AR) Italia
 - Via Guglielmo Marconi, 81 52031 Anghiari (AR) Italia

CERMET **IAF** **ACCREDIA** SGQ N° 6074 - SSI N° 0066
SISA N° 0160 - FSH N° 0041
PRD N° 0698

Certificate

CERTIFICATE OF COMPLIANCE

Certificate Number	20130702-E362672
Report Reference	E362672-20130628
Issue Date	2013-JULY-02

Issued to: LIGHT PROGRESS SRL
 VIA G. MARCONI 81
 52031 ANGIARI AR ITALY

This is to certify that representative samples of ACCESSORIES, AIR-DUCT MOUNTED Duct-Mounted UV Lamp Assembly, Models UV-RACK, followed by 3/, 4/ or 6/, followed by 40H, 60H or 90H.

Have been investigated by UL in accordance with the Standard(s) indicated on this Certificate.

Standard(s) for Safety: Bi-National Standard for Heating and Cooling Equipment, ANSI/UL 1995-2011 and CAN-CSA C22.2 No. 236-11

Additional Information: See the UL Online Certifications Directory at www.ul.com/database for additional information

Only those products bearing the UL Classification Mark for the U.S. and Canada should be considered as being covered by UL's Classification and Follow-Up Service and meeting the appropriate U.S. and Canadian requirements.

The UL Classification Mark includes: the UL in a circle symbol: with the word "CLASSIFIED" (as shown), a control number (may be alphanumeric) assigned by UL, a statement to indicate the extent of UL's evaluation of the product, and the product category name (product identity) as indicated in the appropriate UL Directory. The UL Classification Mark for Canada includes: the UL Classification Mark for Canada: with the word "CLASSIFIED" (as shown), a control number (may be alphanumeric) assigned by UL, a statement to indicate the extent of UL's evaluation of the product, and the product category name (product identity) in English, French, or English/French as indicated in the appropriate UL Directory.

Look for the UL Classification Mark on the product.

William R. Carney, Director, North American Certification Programs
 UL LLC
Any information and documentation involving UL Mark services are provided on behalf of UL LLC (UL) or any authorized licensee of UL. For questions, please contact a local UL Customer Service Representative at www.ul.com/customer-service.

Page 1 of 1



UNIVERSITÀ
DI SIENA
1240

University Tests - Air Treatment



Dpt of Physiopathology, Experimental Medicine and Public Health University of Siena Via Aldo Moro 3, 53100 - SIENA - ITALY Tel +39 0577 234134 - Fax +39 0577 234090 e-mail: epidmol@unisi.it	MOLECULAR EPIDEMIOLOGY Research Division 
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Valutazione dell'effetto che purificatori d'aria a raggi UV-C prodotti da **LIGHT PROGRESS®** hanno sulla carica microbica e fungina presente nell'aria.

University of Siena
Department of Physiopathology,
Exp. Medicine and Public Health
Lab. Molecular Epidemiology
Prof. Emanuele Montomali

Emanuele Montomali
Luca Biondi

Grafico 1

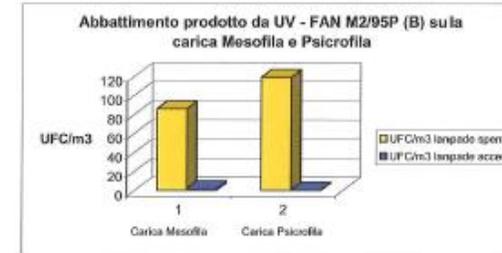
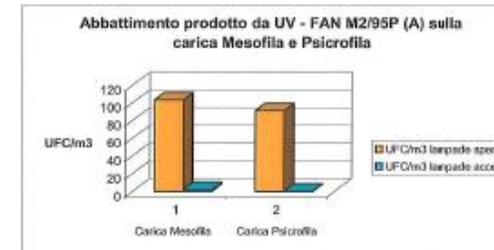


Grafico 2



University of Siena
Department of Physiopathology,
Exp. Medicine and Public Health
Lab. Molecular Epidemiology
Prof. Emanuele Montomali

Luca Biondi



UNIVERSITÀ
DI SIENA
1240

University Tests - Microbial Load Reduction



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Tel +39 0577 234134 Fax +39 0577 234090
e-mail: epidmol@unisi.it

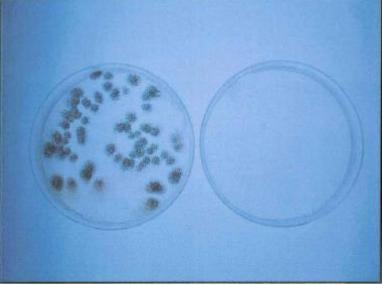
MOLECULAR EPIDEMIOLOGY
Research Division
EpidMol

**Valutazione dell'effetto battericida, sporicida e fungicida
dei raggi UV-C emessi da apparecchi LIGHT PROGRESS®**

University of Siena
Department of Physopathology,
Exp Medicine and Public Health
Lab. Molecular Epidemiology
Prof. Emanuele Montomali

Emanuele Montomali
Antonio Pozzi

Aspergillus niger

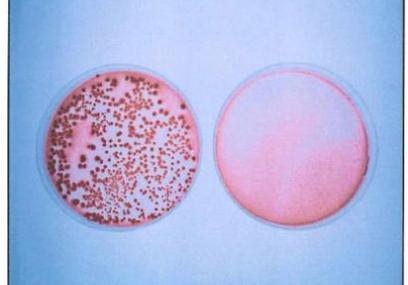


Aspergillus niger su Sabouraud dextrose Agar, a sinistra la piastra non irradiata, a destra la piastra irradiata con UVC

University of Siena
Department of Physopathology,
Exp Medicine and Public Health
Lab. Molecular Epidemiology
Prof. Emanuele Montomali

EM

Escherichia coli

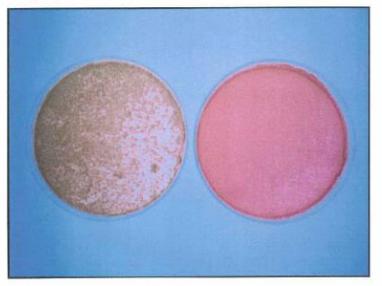


Escherichia coli su MacConkey Agar n.3, a sinistra la piastra non irradiata, a destra la piastra irradiata con UVC

University of Siena
Department of Physopathology,
Exp Medicine and Public Health
Lab. Molecular Epidemiology
Prof. Emanuele Montomali

EM

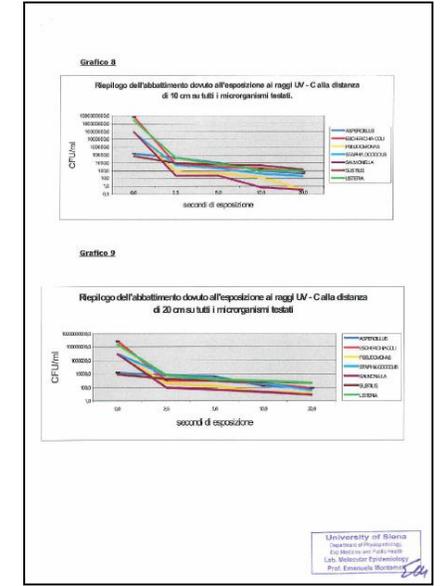
Staphylococcus aureus



Staphylococcus aureus su Mannitol salt agar, a sinistra la piastra non irradiata, a destra la piastra irradiata con UVC

University of Siena
Department of Physopathology,
Exp Medicine and Public Health
Lab. Molecular Epidemiology
Prof. Emanuele Montomali

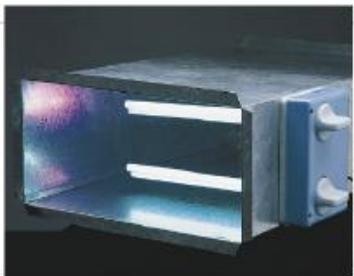
EM



UVGI Design Basics

for Air and Surface Disinfection

Ultraviolet germicidal irradiation lamps can help clean coils and improve indoor air quality



promise that the elimination of airborne disease seemed possible. In 1936, Hart used UVGI to sterilize air in a surgical operating room.¹ In 1937, the first application of UVGI for a school ventilation system dramatically reduced

UVGI for Hospital Applications

Dr. Wladylaw Kowalski

Vice President, Immune Building Systems, Inc., New York, NY, dkowalski@ibsi.com
IUA Air Treatment Symposium, Los Angeles, 2007

INTRODUCTION

Health care facilities are subject to microbiological airborne hazards that can cause infections in both patients and health care workers. Hospital-acquired, or nosocomial, infections have been a persistent problem in hospitals and they can have complex multifaceted etiologies. It is possible that as much as a third or more of all nosocomial infections may be the result of airborne transmission at some point and, if so, air disinfection technologies may be able to reduce the nosocomial infection rate.

If the direct contact route predominates, as many experts believe, then surface disinfection technologies could also have a major impact. Combining air and surface disinfection may be an optimum approach to reduce infection rates and may very well be economical to implement. Existing health care guidelines for ventilation system design, pressurization, filtration, and disinfection procedures have historically had the problem at bay, but emerging nosocomial hazards and increasingly complicated etiologies are creating a demand for new control technologies.

This evolving and growing problem has spawned interest in both existing and developmental technologies, especially among engineers and health care professionals. This presentation summarizes applicable codes and standards, examines the epidemiology of airborne nosocomial infections and their aerobiological pathways, and reviews air and surface disinfection technologies such as ultraviolet germicidal irradiation (UVGI), which may offer more effective solutions. A summary of results from implementation of UVGI systems in hospitals is provided which demonstrates average nosocomial infection rate reductions of over 65%.

Guidelines, Codes, and Standards

Various guidelines, codes, and standards exist that offer details for designing health care facility ventilation systems (AIA 2001, ASHRAE 2001a & 2001b, CDC 1994 & 2003). Some guidelines specifically address problems like TB, nosocomial infections, and surgical site infections (CDC 2005, Wenzel 1991, Mangram et al. 1999, Tacke et al. 1994). While these guidelines provide adequate design information relating to airflow, air exchange rates, and filtration, they do not contain any specific guidelines for UVGI applications and are not reviewed here. In fact, the only current guidelines that provide any detailed

information relating to UVGI air and surface disinfection are the draft IUA guidelines (IUA 2005).

The IUA Guidelines include a description of the operating parameters of UVGI systems intended for effective air treatment, and these are equally applicable to health care facilities. The operating characteristics for successful UVGI system implementation do not differ (i.e. are not more stringent) for hospitals since performance criteria are already near a maximum for any UVGI system that meets the suggested guidelines. Included in the operating parameters are a recommended minimum of 0.25 seconds of UV exposure, an air velocity within the range of 500 fpm to 1,000 fpm, and a recommended rating of UVGI 10 or higher, which corresponds to a minimum UV dose of 5 J/m². Coupled with the requisite filters for hospital applications (per ASHRAE) such combined UVGI/ultrafiltration air cleaning systems will provide high removal rates for all nosocomial bacteria, fungi, and viruses.

Airborne levels in hospitals are not routinely monitored or regulated. For hospital air, WHO recommends relatively exposed levels of 100 cfu/m³ for bacteria and 50 cfu/m³ for fungi, but many facilities would fail to meet these (WHO 1988). Environmental fungal spores should be completely removed per filtration guidelines, and so the presence of any fungal spores in an OR should warrant investigation. According to the criteria of Federal Standard 209E (FD 209E) on cleanrooms, conventionally ventilated operating rooms rank less than class 3.5 (Durrant et al. 2005). A level of 10 cfu/m³, based on the ISO Class 7 cleanroom limit (EU Grade B) used in the pharmaceutical industry and as a target for ultra clean ventilation (UCV) systems, would probably be a more appropriate criterion for hospital ORs and ICU.

Airborne Nosocomial Epidemiology

Airborne nosocomial infections are those that transmit directly or indirectly by the airborne route, and they may cause respiratory (primarily pneumonia) and surgical site infections (SSI). The cost of nosocomial infections in the U.S. is estimated to be about \$4.5 billion annually and various sources estimate that they cause between 2 and 4 million nosocomial infections with some 20-80 thousand fatalities annually (Kowalski 2006). It is not known what fraction of these infections are due specifically to airborne microbes, but since many of these microbes are potentially airborne it could be assumed that a large fraction, perhaps 25% or more, involve airborne transmission at some point in the nosocomial etiology.

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Ultraviolet Germicidal Irradiation

The U.S. General Services Administration requires that UVC be included in cooling coil air-handling units for all new facilities and alteration projects to maintain coil cleanliness

Ultraviolet Lamp Systems

Table 3 Advantages and Disadvantages of UVC Fixture Location Relative to Coil

Location	Advantages	Disadvantages
Downstream	More space to install fixtures. Allows fixtures to better irradiate surface where condensation is highest. Allows fixtures to irradiate generally most contaminated part of coil and drain pan.	Lamp and fixture must be sized for damp location. Lamp coating often may reduce UV output, or require vented coil connection or more lamps and fixtures for a given result.
Upstream	Lamp and fixture may be subjected to less moisture. May be the only location to apply fixtures. Fixed lamps and fixtures may be needed that are downstream side.	May not allow enough space to install fixtures. May initially take longer to clean coil and may not disinfect drain pan.

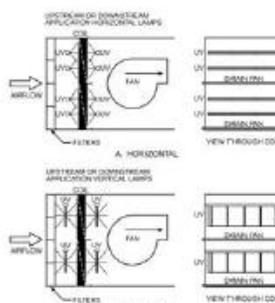


Fig. 7 UV Lamps Upstream or Downstream of Coil and Drain Pan

note to ensure that electrical interlocks are included to cleanze the UV system when it is accessed. UV systems should operate continuously to maximize UV's benefits and to increase lamp life, and to combat mold and bacteria growth that occurs when an HVAC system is not operating.

UVGI systems can be installed upstream or downstream of the cooling coil (Figure 3). Both locations have advantages and disadvantages, as shown in Table 3. Figure 2 shows an actual installation at a coil.

Upper-Air UVGI Systems

Upper-air irradiation systems are designed to irradiate only air in the upper part of the room. Their narrow, focused beams is placed parallel to the plane of the ceiling and prevents any ultra-violet rays from engaging an occupants below. Upper-air systems rely on air convection and mixing to move air from the lower to the upper portion of the room, where it can be irradiated and airborne microorganisms inactivated (Koffly and Busch 1972). Many fixtures



Fig. 8 Horizontal Lamp Placement for Coil Surface Disinfection

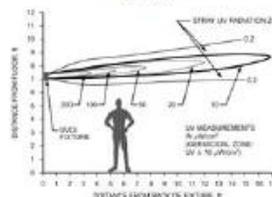


Fig. 9 Typical Elevation View

incorporate a safety switch that breaks the circuit when fixtures are opened for servicing, and should contain baffles or louvers appropriately positioned to direct UV irradiation to the upper air space. Baffles and louvers must never be bent or deformed.

Upper-room UVGI fixtures typically use low-pressure UVC lamps in tubular and compact shapes, and require a variety of electrical wattages. Beyond lamp size, shape, and ballast, fixtures are designed to be open or restricted in distribution, depending on the physical space to be treated.

Ceiling height above 10 ft allow more for more open fixtures, which are more efficient. For occupied spaces with lower ceilings (less than 10 ft), various suspended upper-room UVGI fixtures (wall, pendant, and ceiling) are available to be mounted in combinations at least 7 ft from the floor to the bottom of the fixture. Figure 3 shows some typical elevations and corresponding UV levels, and Figure 10 illustrates distribution in a room.

Indoor Air Quality Guide

Best Practices for Design, Construction, and Commissioning



Developed by:
American Society of Heating, Refrigerating and Air-Conditioning Engineers
The American Institute of Architects
Building Owners and Managers Association International
Sheet Metal and Air Conditioning Contractors' National Association
U.S. Environmental Protection Agency
U.S. Green Building Council



Best Practice for Coil Cleaning

Typically used in buildings: in-duct, to provide a high level of ultraviolet irradiation past the lamps. Upper room fixtures are shielded from direct radiation to create currents that move air from rooms with low air turnover into the delivery plenum. This irradiation activates microorganisms that are moving air stream.

to provide radiation at the microorganisms. The lamps present lamp but differing in another difference is that UVC transmits UVC, rather than

These guidelines deal primarily with issues related to placement of UVC systems in air handling units in the proximity of the cooling coil.

How important is indoor air quality?

Evidence strongly suggests that poor environments in schools, primarily due to the effects of indoor pollutants, adversely influence the health, performance and attendance of students and teachers. This evidence links high concentrations of several air pollutants to reduced school attendance. There is also persuasive evidence that microbiological pollutants are associated with increases in asthma effects and respiratory infections, both of which are related to lower school performance and attendance.² UVC lights offer a potentially effective means of both reducing energy use and delivering fresh air to improve classroom air quality.

UVC lamps are designed to clean both the coil and drain pan surfaces in a few hours or a few days³ and to progressively penetrate between the coil rows and fins with time. Indoor air quality may be improved since the coils that are continuously cleaned by UVC are thus no longer an incubation site for microorganisms. Air flowing through the coils is therefore not contaminated, resulting in cleaner air being delivered to the classroom.

What are the maintenance issues with UVC?

An effective traditional coil cleaning program cleans the coils three to four times per year. Use of UVC lamps can eliminate the need for these costly, tedious cleaning treatments that create system downtime and use chemicals, biocides or pressure washing. Mechanical or chemical washing may also damage coils. Maintenance benefits may accrue from use of UVC lights to keep coils continuously clean, avoiding these laborious coil cleaning actions that will otherwise be required to return coils to a clean condition. UVC lamps should be inspected to see if they are dirty and then cleaned on a regular basis, as needed. Some installations have a view port to permit visual observation of the

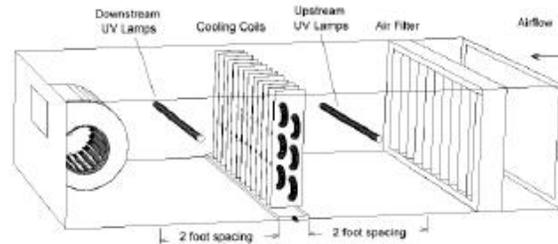


Figure 2.1: Location and spacing for UVGI system in an air handling unit.

2.2 Location of UV Lamp Ballasts

UV lamp ballasts should preferably be located external to the ventilation system although this is not currently a strict requirement due to so many systems that have integral lamp ballasts that must be located wherever the lamp is located. One of the problems with lamp ballasts being located inside air handling units is that they may be exposed to temperature and humidity extremes.

If lamp ballasts are located in an internal lamp housing, the housing should be of drip-proof construction or other approved housing method. If lamp ballasts are located external to the air handling unit or ductwork, the wiring must be run through conduit such that there is no exposed wiring inside the air handling unit. Exposed wiring may be subject to deterioration inside and air handling unit and may also be exposed to UV irradiation, which may cause photodegradation over time and thus pose a fire hazard.

2.3 Operating Conditions

Both the UV lamp and the ballast should be located such that the ambient operating conditions (i.e. temperature and relative humidity) are within the component design or operating limits. Refer to manufacturer's information for design operating conditions. In general, both UVGI and filters are designed to operate at an air velocity of 500 fpm, although some lamps may be suitable for operation at higher velocities. Variations in air velocity (i.e. +/- 100 fpm) may be acceptable depending on the manufacturer's lamp but such variations should be evaluated to include or assess the impact on UV output. See IUVA-G01A-2005, "General Guideline for UVGI Air and Surface Disinfection Systems," for

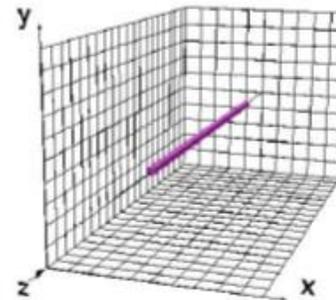


Figure 5.1: Grid for a 10x10x20 Matrix and Coordinate System, shown with a lamp in an axial configuration.

5.2 Operation of the Program

The program takes the input data from an input text file, performs the analysis and outputs results in a text file. Intermediate results can be extracted and graphed in spreadsheets.

Input data requires definition of the coordinate system. The lamp coordinates are based on the lower left front corner of the matrix being at (0, 0, 0). The indices for both the large and small matrices are also based on this (0, 0, 0) point.

Using the input the enclosure intensity field is determined by evaluating the direct intensity field of the lamp, the first reflection intensity field, and the total inter-reflected intensity field. These are summed to produce the total intensity field of the enclosure. This process is shown by the flow chart in Figure 5.2.

As mentioned previously, the inter-reflections are only computed for three iterations, after which the total bulk average intensity is determined mathematically for the remaining inter-reflections. Each of the first three inter-reflection calculations involves computing the exchange of radiative energy from each of the blocks on the other three sides, for all four walls. The summed result produces the wall intensity contours for the next set of inter-reflection calculations. This is the most calculation-intensive portion of the program and takes up the most operating time. In comparison, the direct and first reflection calculations proceed relatively rapidly.

Because two different size matrices are used for the computations, it is necessary to scale up the smaller matrix to match the size of the larger matrix prior to adding them. This is

Effective UVGI System Design Through Improved Modeling

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ABSTRACT

This paper summarizes an improved methodology for predicting the rate of air stream disinfection for UVGI systems that will enable effective designs and lower energy costs. This approach uses radiative view factors to define the three-dimensional intensity field for lamps and reflective surfaces inside enclosures. Lamp photometric data for a variety of lamps are shown to agree more closely with the view factor model than with models using the Inverse Square Law. The intensity field due to reflection from internal surfaces is determined by assuming diffuse reflectivity. An analytical method is used to determine the inter-reflection component of intensity due to multiple internal reflections. The superposition of these components yields a three-dimensional intensity field matrix that can be used to calculate disinfection rates for any given microbial rate constant. Results from laboratory bioassays using 5. aureococcus in various duct configurations have corroborated model predictions within ±15% in most cases.

INTRODUCTION

Currently available design information has not guaranteed predictable performance for UVGI air disinfection systems. Some of today's design practices can overdesign systems, leading to prohibitive costs and high energy consumption. Other design practices lead to undersized and ineffective systems. Design practices have not changed in decades, and it is worthwhile to review the history of UVGI applications to discover how this situation has come to be.

Although the first UVGI water disinfection system was implemented in 1909 (AWWA 1971), the first UVGI systems designed for airstream disinfection weren't implemented until the 1930s (Shapp 1940). Based on limited laboratory data and

using newly available UVGI lamps, these systems were sized without the benefit of positioning criteria. Tests, either air sampling or epidemiological, were used to determine their efficacy. Some of these systems were highly successful, such as those used to control measles in schools, and one used by Riley to eliminate TB bacilli from hospital ward exhaust air (Riley and O'Grady 1961).

Other designs appeared to be ineffective, with the result that the initial glowing reviews of this technology became tempered. Guidelines were issued that sanctioned the use of UVGI only in combination with HEPA filters (Luciano 1977; ASHRAE 1994). No studies were ever undertaken to determine the root cause for any UVGI system failures. Apart from improvements in lamp designs, applications technology for airstream disinfection has remained almost stagnant for decades.

The first design guidelines for UVGI airstream disinfection systems were developed in the 1940s (Luckock and Holladay 1942; Luckock 1946). Versions appeared in catalogs that continue to be reproduced and used today (Philips 1995). These guidelines offer procedures, charts, and tables to size lamps and reflective surfaces so as to obtain a desired disinfection rate. These sizing methods, though admirably detailed for the period, suffer from a number of deficiencies:

1. They fail to define the intensity field, instead merely using the lamp rating or else relying on photometric data for lamp output.
2. Lamps are specified without regard to lamp location or type.
3. The correction factor for rectangular ducts ignores the intensity field variations due to surface reflectivity.

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Some



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