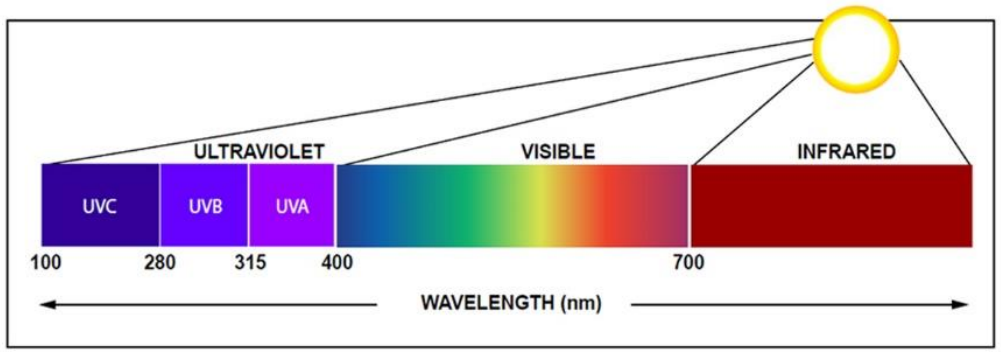
LIGHT PROGRESS

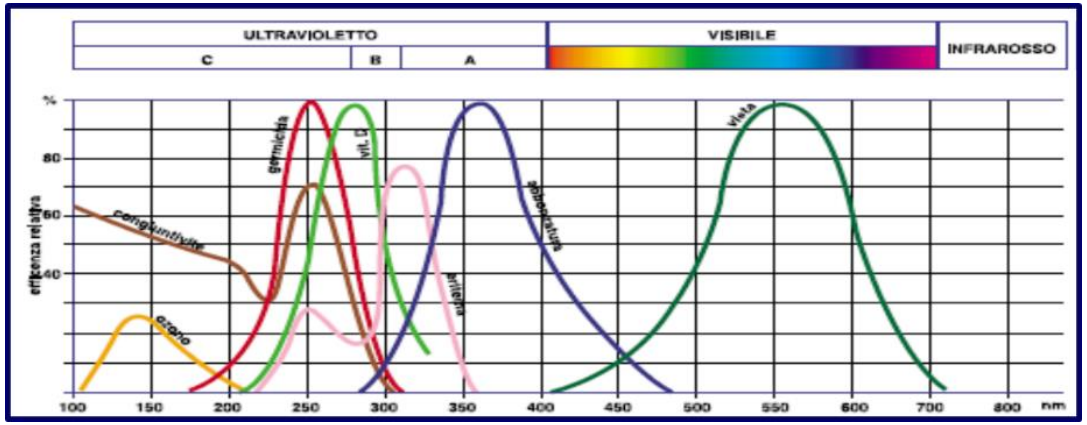
UltraViolet Germicidal Irradiation (UVGI)

UVGI – an overview

Ultraviolet Germicidal Irradiation is known from the 60s as a good physical method to control growth and distribution of microbial organisms, pathogens, spores, moulds, etc.

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 :

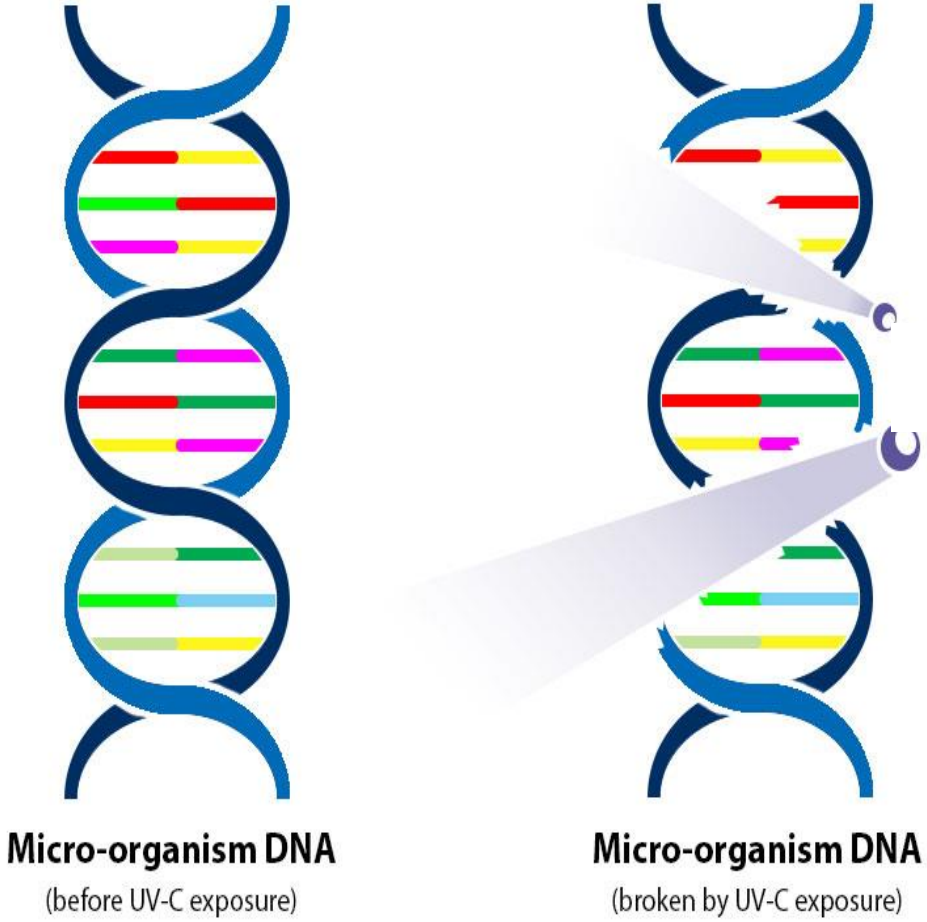
- UV - A (with tanning properties),
- UV - B (with therapeutic properties)
- UV – C (with germicidal properties).

What does UVGI mean ?

The absorption of a UV photon by the DNA of microrganisms 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, Molds 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.

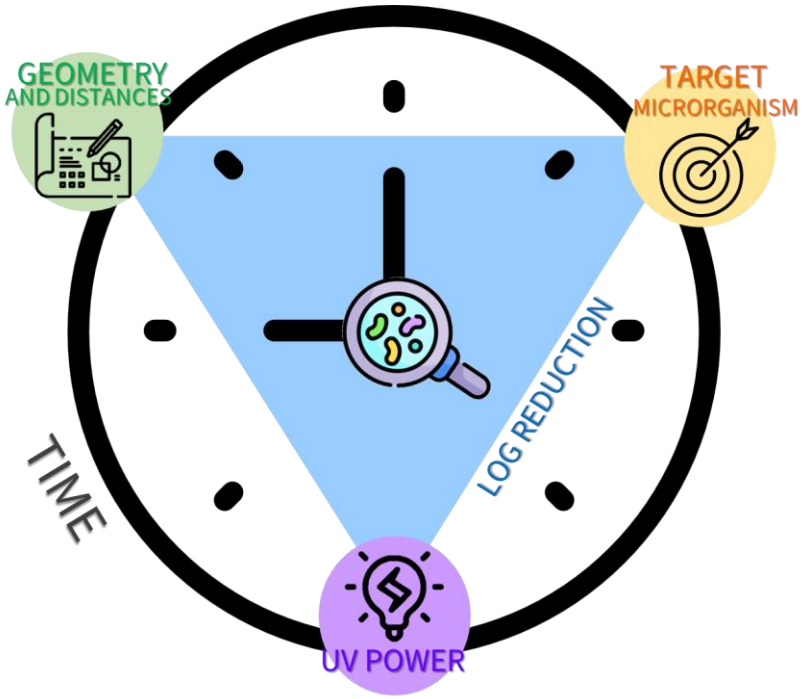


UV Disinfection Key Factors

Each microorganism has a specific UV-resistance threshold, called DOSE. The specific dose need to be delivered to get a proper disinfection level, which is expressed in LOG REDUCTION (1 Log=90%, 2 Logs=99%, 3 Logs=99,9%, etc).

Therefore, for some microorganisms a low level of UV POWER is sufficient to be eliminated, while for others it takes more power to get same elimination level...or alternatively a longer exposure TIME.

These factors are essential to understand UV technology:



- Disinfection level that needs to be achieved (Log Reduction);
- Target pathogen (and its dose);
- UV power in play;
- Exposure time / geometry and distance balance;

UV DOSE needed to eliminate 99% (2 Logs) value in (µW/cm2 SEC)

BACTERIA		Virus (genieric, DNA e RNA)	
Mycobacterium tuberculosisn (TBC)	4300	Virus dell' influenza A	4558
Escherichia coli ATCC 11229	4800	Hepatitis A HM175	8000
Legionella pneumophila ATCC 33152	3200	Corona Virus (SARS-CoV1 – MERS-Cov)	1200-1500
Pseudomonas aeruginosa ATCC 9027	6500	Rotavirus	15000
Salmonella ATCC 6539	4500	Molds	
Staphylococcus aureus	3200	Aspergillus Amstelodami	66700
Streptococcus hemolyticus	4400	Aspergillus Brasiliensis (Niger)	226000
Vibrio cholerae	4100	Yeasts	
MRSA	6550	Comuni lieviti dolciari	12000
Clostridium Difficile	10000	Lievito di birra	20000

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SANITATION means bringing the microbial load into acceptable and optimal hygiene standards that depend on the intended use of the environments concerned. Sanitation is often used to mean “clean” and must however be preceded by cleaning.

DISINFECT means to reduce the microbial load deeply, that is to eliminate at least 1 log (90%) of the bacteria present. Microbial load reduction is a basic value in disinfection and it is expressed in Log Reduction.
A good disinfection level is around 2Logs (99%) a very good disinfection is 3Logs (99,9%), and 4Logs (99,99%) is considered a pretty high standard.

STERILITY is the closest level anyone can get to achieve complete reduction of microbial load, we can talk about sterilization only if reduction is proved to be not less than 6Logs, meaning 99,9999%.

To declare sterility test has to be proved and certified by third parts by law.

SANITATION

DISINFECTION

STERILIZATION

our Company

Light Progress

studies, develops, projects and manufactures

Ultraviolet Germicidal Irradiation devices

LIGHT PROGRESS

MADE IN ITALY

LIGHT PROGRESS

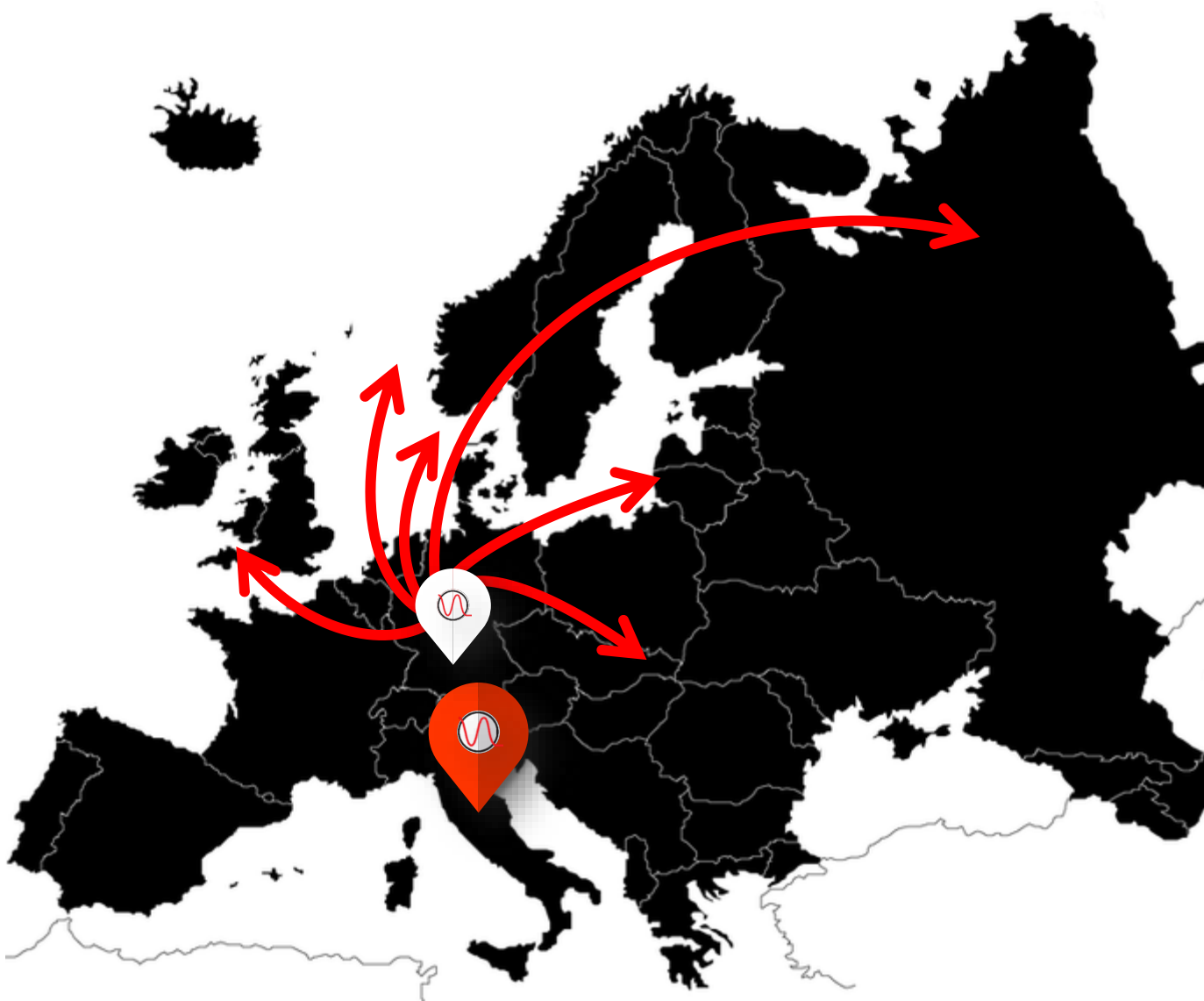
2019 -

New German Branch Office, Frankfurt.

Light Progress has a brand-new office to follow clients from Germany, Austria, Switzerland, UK, and East and North EU in general. Russian market is also a one of our future target.

Main goal is to increase our presence in these countries and be able to offer better assistance to Key Accounts.

One new Business Development Manager has been employed to strength our Brand Identity and offer a better service for old and new clients.



LIGHT PROGRESS

Great reseller and distributors network

Standards

LIGHT PROGRESS

CERTIFIED ISO 9001:2015 COMPANY

CERTIFIED ISO 13485

CE

RoHS Compliant

UL

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

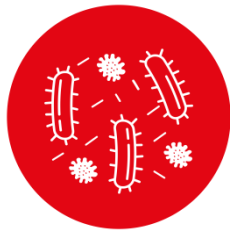
INTERNATIONAL IUVA ULTRAVIOLET ASSOCIATION

FDA REGISTERED

Benefits

LIGHT PROGRESS

We eliminate every harmful microorganism, up to 99,999%



We improve your product Quality

We ensure you safety

We support sustainability

We make you save money

Our team is there to support you

why LIGHT PROGRESS ?

We offer the **widest product range** of UVGI Devices on the market, providing different solutions, great quality, 100% Made in Italy.

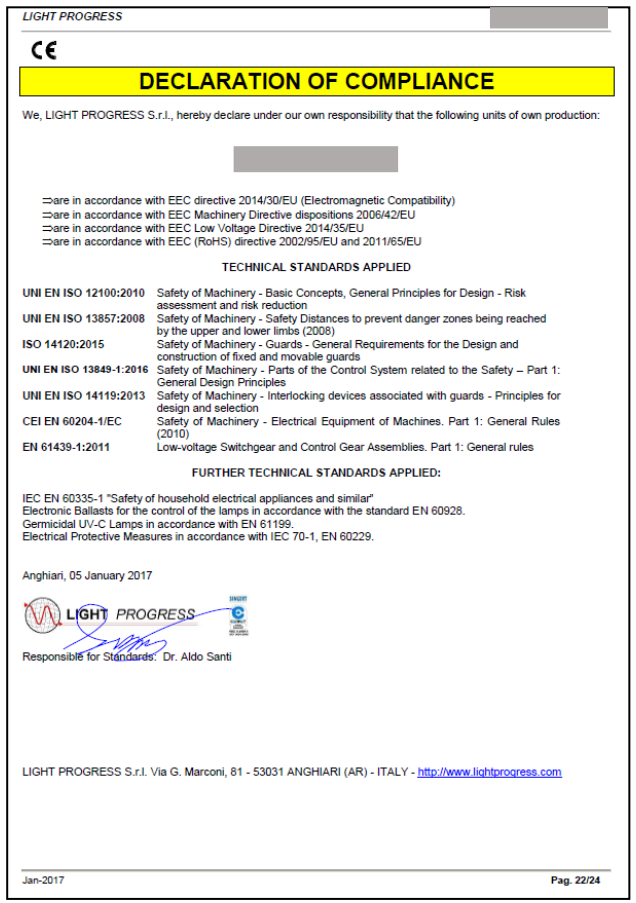
Our Team sizes and projects every application designing a **custom solution** for each specific case, we invest in R&D e work together with Universities and big companies, leaders in their field.

Our products **fit in different application fields**, such as Healthcare, Food Industries, Water Treatment, Odour reduction, HVAC, Public Trasports, etc. with thousand clients in Italy and abroad.

LIGHT PROGRESS

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

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.

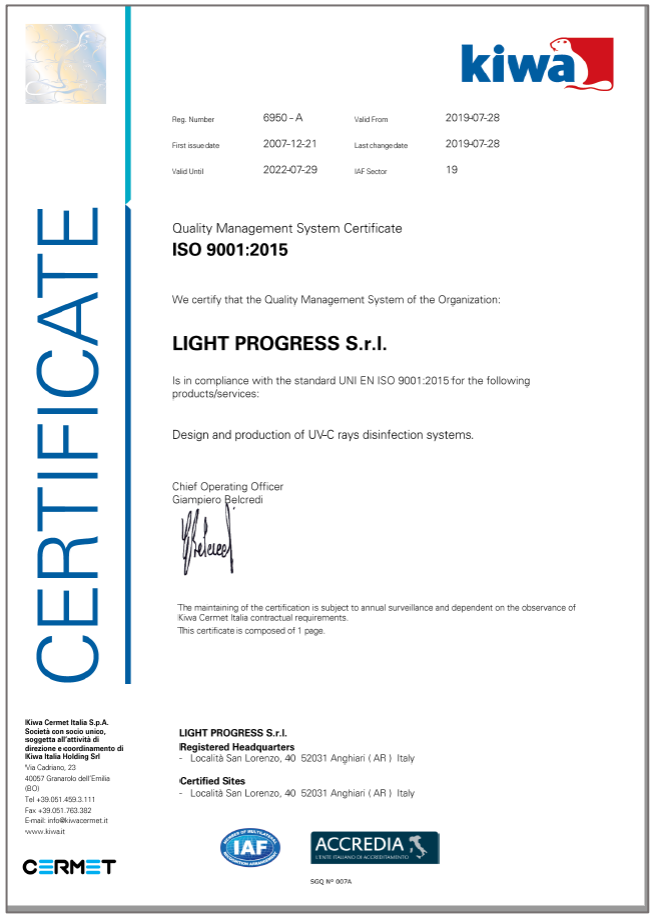
Anghiari, 05 January 2017

LIGHT PROGRESS

Responsible for Standards: Dr. Aldo Santi

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

Jan-2017 Pag. 22/24



CERTIFICATE

kiwa

Reg. Number	6950 - A	Valid From	2019-07-28
First issue date	2007-12-21	Last change date	2019-07-28
Valid Until	2022-07-29	IAF Sector	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

The maintaining of the certification is subject to annual surveillance and dependent on the observance of Kiwa Cermet Italia contractual requirements.
This certificate is composed of 1 page.

Kiwa Cermet Italia S.p.A.
Società con socio unico, soggetta all'attività di direzione e coordinamento di Kiwa Italia Holding Srl
Via Cadriano, 23
40057 Granarolo dell'Emilia (BO)
Tel +39.051.459.3.111
Fax +39.051.763.382
E-mail: info@kiwacermet.it
www.kiwa.it

CERMET

LIGHT PROGRESS S.r.l.
Registered Headquarters
- Località San Lorenzo, 40 52031 Anghiari (AR) Italy

Certified Sites
- Località San Lorenzo, 40 52031 Anghiari (AR) Italy

IAF ACCREDIA

SGQ N° 007A

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 ANGHIARI 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

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Page 1 of 1

*Available for selected items

University Tests - Air Treatment

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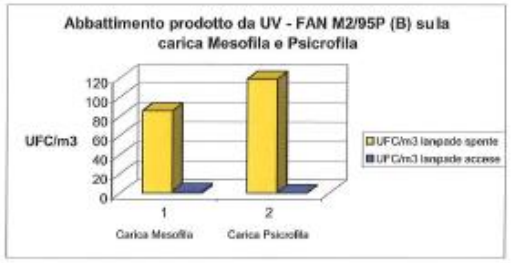
Tel +39 0577 234134 - Fax +39 0577 234090
e-mail: epidmol@unisi.it

MOLECULAR EPIDEMIOLOGY
Research Division
EpidMol

Valutazione dell'effetto 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 Montomoli

Grafico 1



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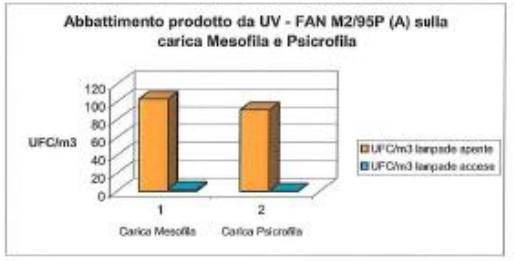

University of Siena
Department of Physiopathology, Exp Medicine and Public Health
Lab. Molecular Epidemiology
Prof. Emanuele Montomoli

University Tests - Microbial Load Reduction

UNIVERSITÀ DI SIENA
1240

LIGHT PROGRESS

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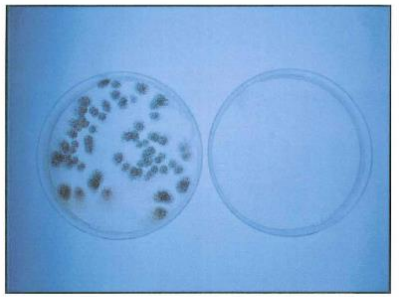
MOLECULAR EPIDEMIOLOGY
Research Division
EpidMol

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

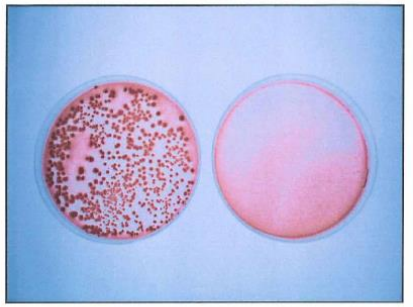
University of Siena
Department of Physiopathology, Exp Medicine and Public Health
Lab. Molecular Epidemiology
Prof. Emanuele Montomoli

Aspergillus niger



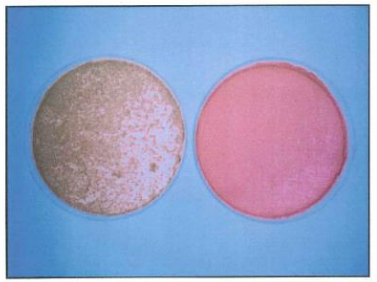
Aspergillus niger su Sabouraud dextrose Agar, a sinistra la piastra non irradiata, a destra la piastra irradiata con UVC

Escherichia coli



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

Staphylococcus aureus



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

Grafico 8

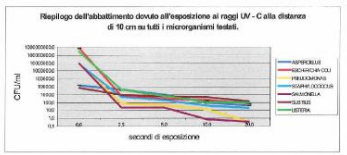
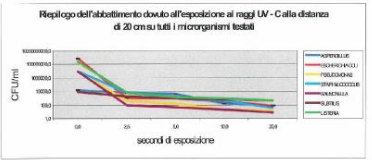


Grafico 9

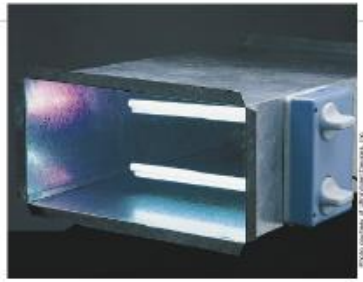


Best Practice

LIGHT PROGRESS

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. Wladyslaw Kowalski

Vice President, Immune Building Systems, Inc., New York, NY, drkowalski@ibsix.com

IUVA 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 held 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 2003a & 2003b, CDC 1994 & 2003). Some guidelines specifically address problems like TB, nosocomial infections, and surgical site infections (CDC 2005, Wenzel 1981, Mangram et al 1999, Tablan 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 IUVA guidelines (IUVA 2005).

The IUVA Guidelines include a description of the operating parameters of UVGI systems intended for effective air treatment, and these are equally applicable to health care applications as well as to commercial buildings and other 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 +/-100 fpm, and a recommended rating of MRV 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/filtration 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 relaxed limits 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 (Darmus et al 2005). A limit 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

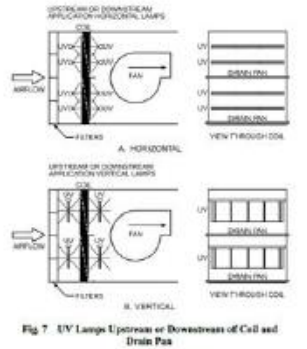
Airborne nosocomial infections are those that transmit directly or indirectly by the airborne route, and they may cause respiratory (primarily pneumonia) and surgical site infections (SSIs). The cost of nosocomial infections in the U.S. is estimated to be about $4-5 billion annually and various sources 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.

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

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 rated for damp location. Lamp cooling effects may reduce UV output, or require windchill correction 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. Fewer lamps and fixtures may be needed than on downstream side.	May not allow enough space to install fixtures. May initially take longer to clean coil and may not disinfect drain pan.



A. HORIZONTAL

B. VERTICAL

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

site to ensure that electrical interlocks are included to disengage the UV system when it is accessed. UV systems should operate continuously to maximize UV's benefits and to improve lamp life, and to counteract 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 7). Both locations have advantages and disadvantages, as shown in Table 3. Figure 8 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 beam is placed parallel to the plane of the ceiling and prevents stray ultraviolet rays from impinging on 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 (Kethley and Branch 1972). Many fixtures

Fig. 8 Horizontal Lamp Placement for Coil Surface Disinfection

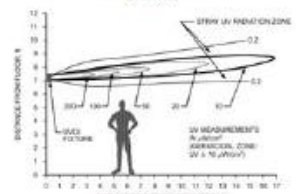


Fig. 9 Typical Elevation View

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 heights above 10 ft allow more for more open fixtures, which are more efficient. For occupied spaces with lower ceilings (less than 10 ft), various louvered upper-room UVGI fixtures (wall, pendant, and corner) are available to be mounted in combinations at least 7 ft from the floor to the bottom of the fixture. Figure 9 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

lly used in buildings: in-duct, de a high level of ultraviolet past the lamps. Upper room the occupants, shielded from rces to create currents that rooms with low air turnover. in pan in the delivery plenum tivates macroorganisms that This irradiation of stationary r intensity requirements than moving air stream.

to provide radiation at the macroorganisms. The lamps prescent lamp but differing in nother difference is that UVC transmits UVC, rather than

These guidelines deal primarily with issues related to placement of UVC systems in air handing 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 macrobiological 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 days[3] 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

Scientific Studies

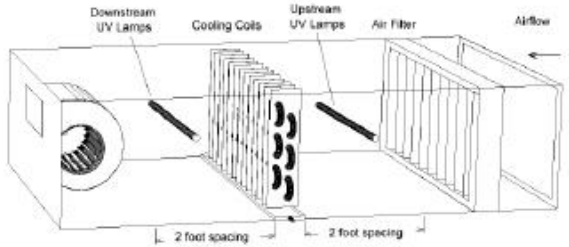


Figure 2.1: Location and spacing for UVGI system in an air handling unit.

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

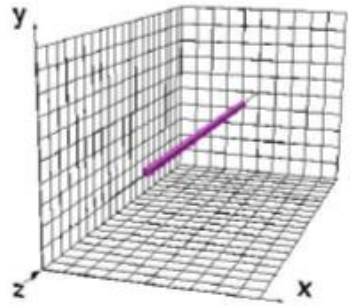


Figure 6.1: Grid for a 10x10x20 Matrix and Coordinate System, shown with a lamp in an axial configuration.

6.2 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 6.2.

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

W.J. Kowalski, P.E.
Student Member ASHRAE

William P. Bahnfleth, Ph.D., P.E.
Member ASHRAE

ABSTRACT

This paper summarizes an improved methodology for predicting the rate of airstream 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 reflectivity 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 S. marcescens 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 (Sharp 1940). Based on limited laboratory data and using newly available UVGI lamps, these systems were sized without the benefit of preexisting 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 1991). No studies were ever undertaken to determine the root cause for any UVGI system failures. Apart from improvements in lamp designs, application technology for airstream disinfection has remained almost stagnant for decades.

The first design guidelines for UVGI airstream disinfection systems were developed in the 1940s (Luckiesh and Holladay 1942; Luckiesh 1946). Versions appeared in catalogs that continue to be reproduced and used today (Philips 1985). 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 endpoints.
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.

W.J. Kowalski is a doctoral candidate and **William P. Bahnfleth** is an associate professor in the Department of Architectural Engineering, Pennsylvania State University, University Park, Pa.

our Product Range

LIGHT PROGRESS

DIRECT IRRADIATION

UV REFLEX

UV FLOW

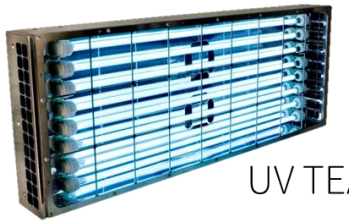
UV DIRECT

UV STICK

UV PIPE

UV STYLO

TEAM OF LAMPS



UV TEAM

UV TEAM-A

AIR PURIFIERS

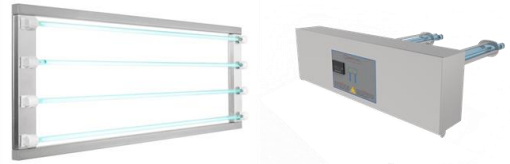
UV-FAN

WATER TREATMENT

UV WATER

AIR CONDITIONING

UV DUCT



UV RACK

UV STYLO

UV STICK-SCR

UV MAX

FAT AND SMELL

UV SMELL

UV STYLO S

UV CABINET

BOX AND CABINETS

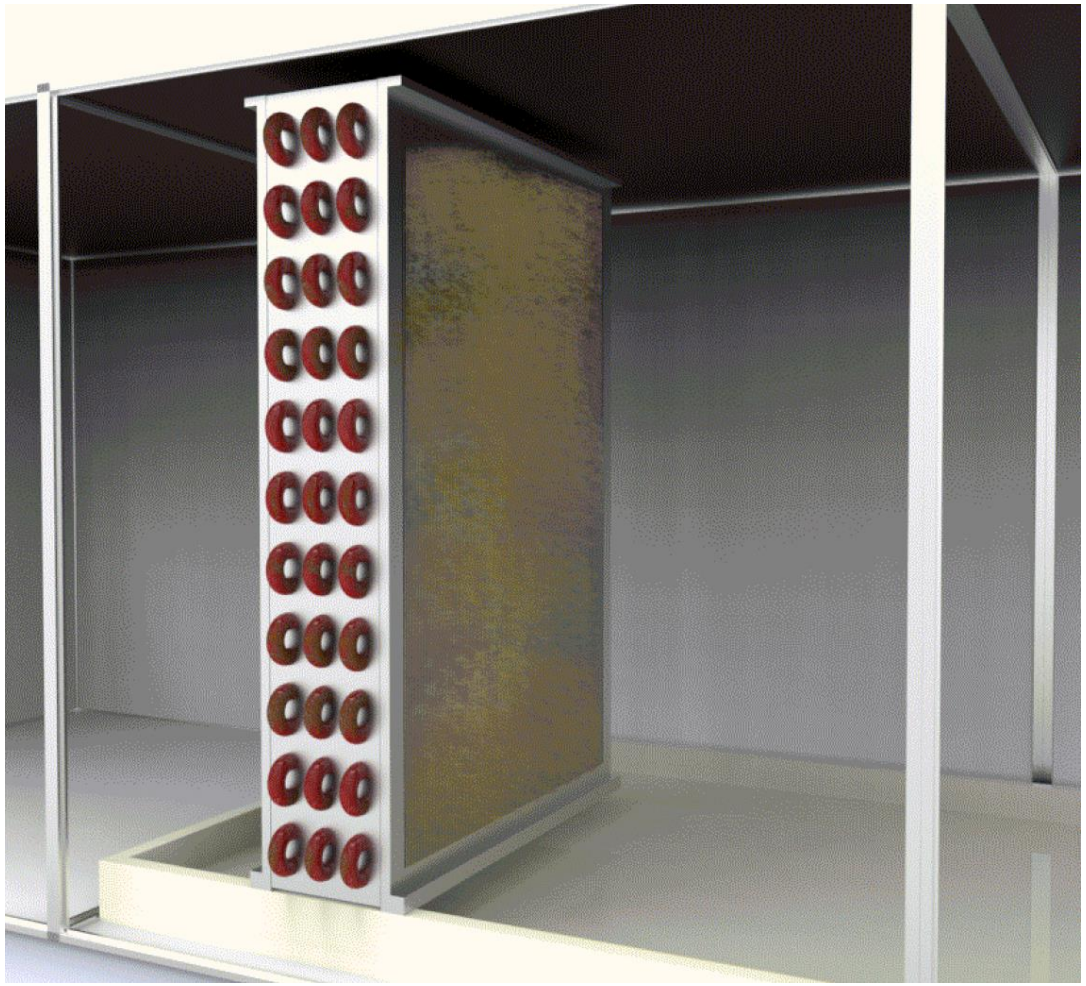
UV BOX

LIGHT PROGRESS

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 ?

LIGHT PROGRESS

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

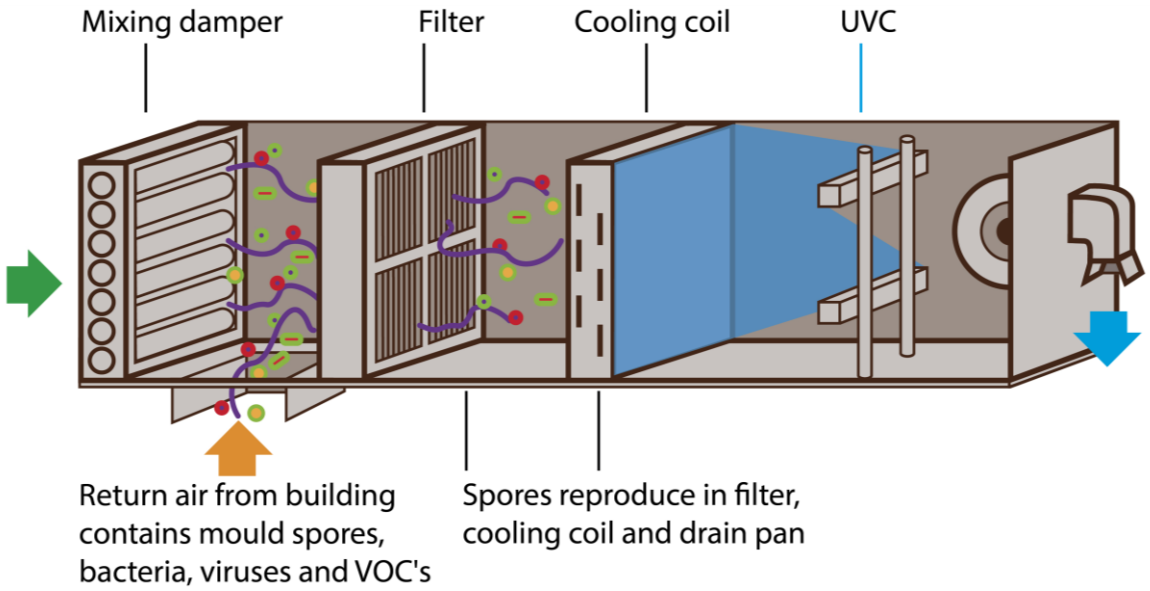
Benefits of using

LIGHT PROGRESS

devices

- HEALTH
- ECOLOGY
- COSTS

UV Disinfection- Air Flow Treatment



The integration of UV technology inside the air conditioning in centralized units allows to treat the air in closed rooms, 24 hours a day, without limits.

With the use of LIGHT PROGRESS products, the indoor Air Quality (IAQ) is improved, thanks to a real air "washing" due to the gradual lowering of the microbial load in a simple, immediate and safe way and without the slightest contraindication.
UV does not leave residues, so the environments do not need to be ever ventilated.

For an effective treatment (99.9% reduction) it takes just a few moments.
By diluting the microbial charge in the air Indoor Air is immediately healthier, with substantial advantages for occupants.

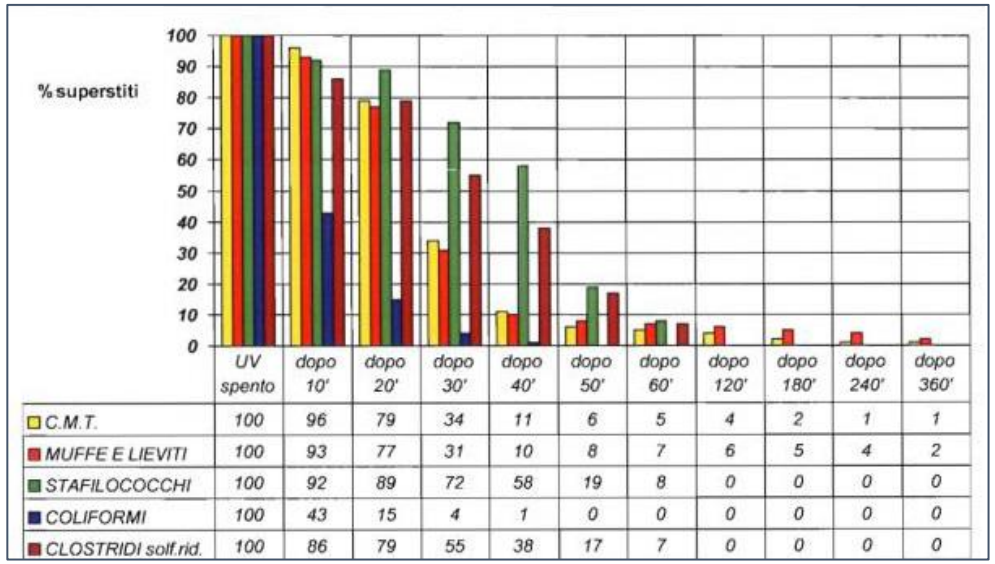
UV Disinfection- Air Flow Treatment

Our products are designed to fit perfectly in various sections of the Air Handling Units, as well as inside the ducts.

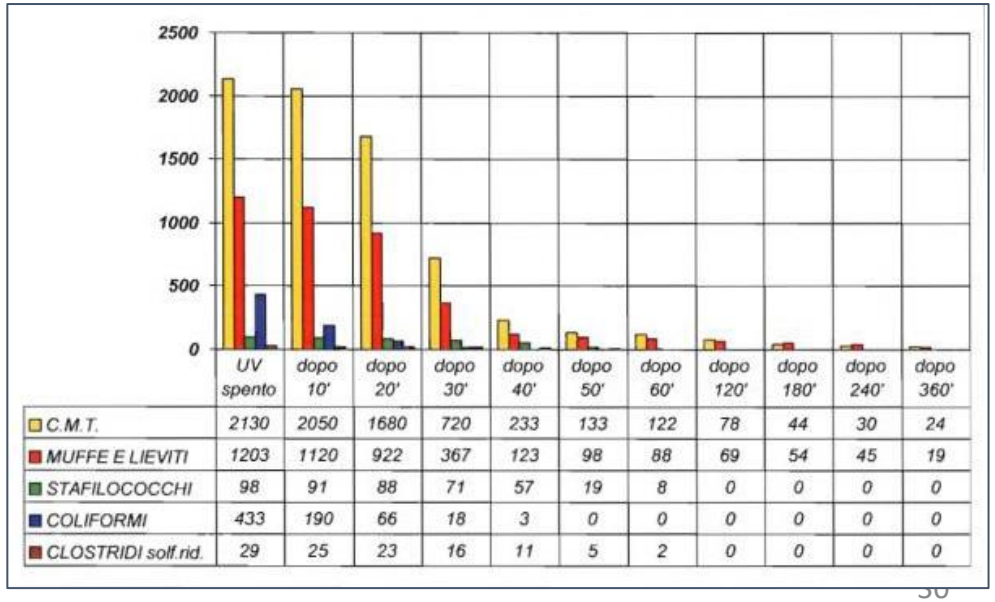
All our HVAC products are dimensioned according to the air conditioning system in order to guarantee safe results in certain times.

Light Progress systems are specific for different uses, inspired by real applications and
improved over the decades thanks to a very close relationship with installers and end-users.

As you can see from the graphs alongside, found on "Study on UV-FAN M1 25 efficacy by Siena Univ", the percentages of microbial reduction of Light Progress systems are between 99.99% for bacteria and 99% for viruses, at EACH air passage.



	UV spento	dopo 10'	dopo 20'	dopo 30'	dopo 40'	dopo 50'	dopo 60'	dopo 120'	dopo 180'	dopo 240'	dopo 360'
C.M.T.	100	96	79	34	11	6	5	4	2	1	1
MUFFE E LIEVITI	100	93	77	31	10	8	7	6	5	4	2
STAFILOCOCCHI	100	92	89	72	58	19	8	0	0	0	0
COLIFORMI	100	43	15	4	1	0	0	0	0	0	0
CLOSTRIDI solf.rid.	100	86	79	55	38	17	7	0	0	0	0



	UV spento	dopo 10'	dopo 20'	dopo 30'	dopo 40'	dopo 50'	dopo 60'	dopo 120'	dopo 180'	dopo 240'	dopo 360'
C.M.T.	2130	2050	1680	720	233	133	122	78	44	30	24
MUFFE E LIEVITI	1203	1120	922	367	123	98	88	69	54	45	19
STAFILOCOCCHI	98	91	88	71	57	19	8	0	0	0	0
COLIFORMI	433	190	66	18	3	0	0	0	0	0	0
CLOSTRIDI solf.rid.	29	25	23	16	11	5	2	0	0	0	0

UV Disinfection- Air Flow Treatment

Many world-class bodies and organizations such as WHO, EPA, CDC, ASHRAE have been recommending the use of UV-C rays for the disinfection of water, environments and air conditioning systems for decades.

The use of UV-C rays is also indicated for the prevention of Coronavirus Sars-Cov-2 and, following the recent COVID-19 pandemic, the implementation of “UV sections” inside HVAC systems is finally increasing as solution to avoid the spread of virus contamination.

ASHRAE American Society of Heating, Refrigerating and Air-conditioning Engineers

World Health Organization

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

CDC CENTERS FOR DISEASE CONTROL AND PREVENTION

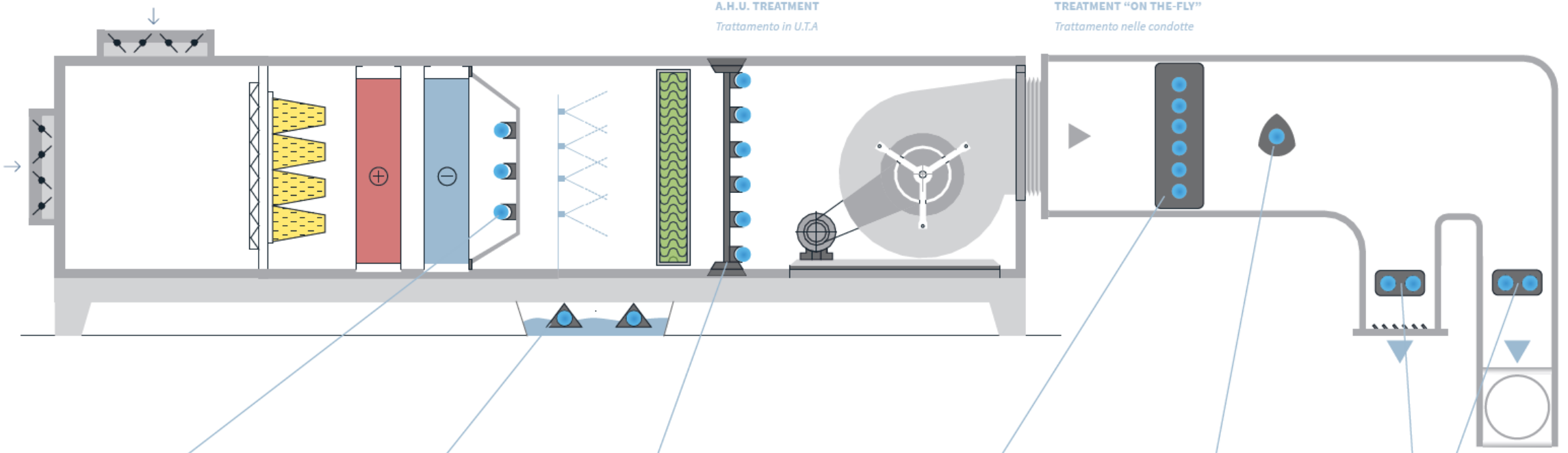
What are LIGHT PROGRESS devices designed to improve Indoor Air Quality and comfort ?

LIGHT PROGRESS

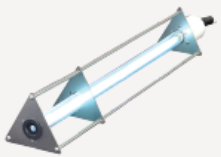
Application Scheme

A.H.U. TREATMENT
Trattamento in U.T.A

TREATMENT "ON THE-FLY"
Trattamento nelle condotte

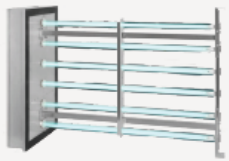


1. UV-STICK-SCR / UV-STICK-SCR-UL



3. UV-STYLO-E

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



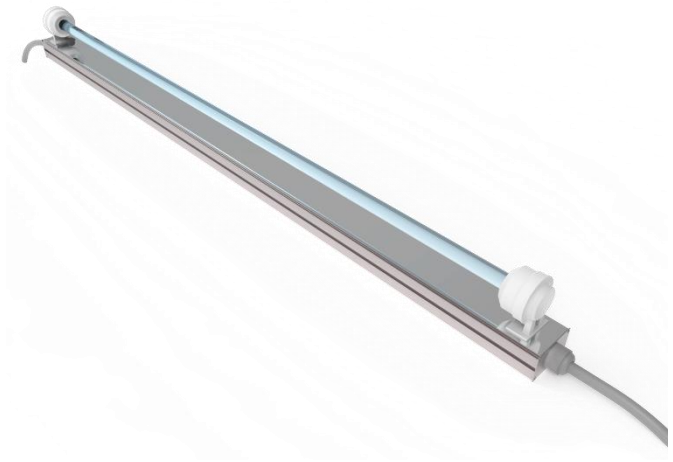
2. UV-RACK / UV-RACK-UL

5. UV-STYLO-X

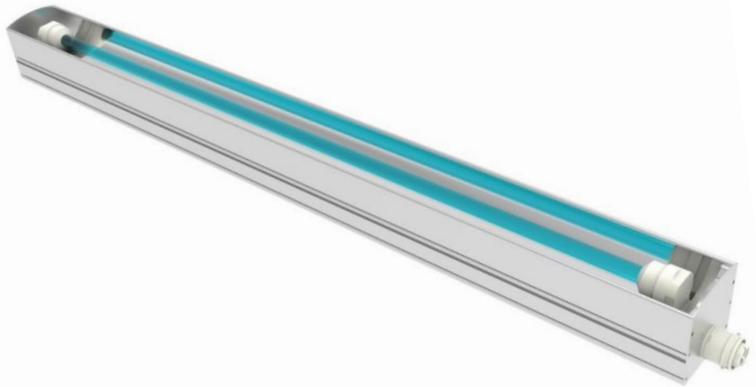
6. UV-DUCT-FL

LIGHT PROGRESS

UV-STICK-SCR



UV-STICK-AX…SCR
Aluminum body + plain Reflector



UV-STICK-AL…SCR
Aluminum + Parabolic Reflector

UV-STICK-NX…SCR
Stainless Steel body + plain reflector

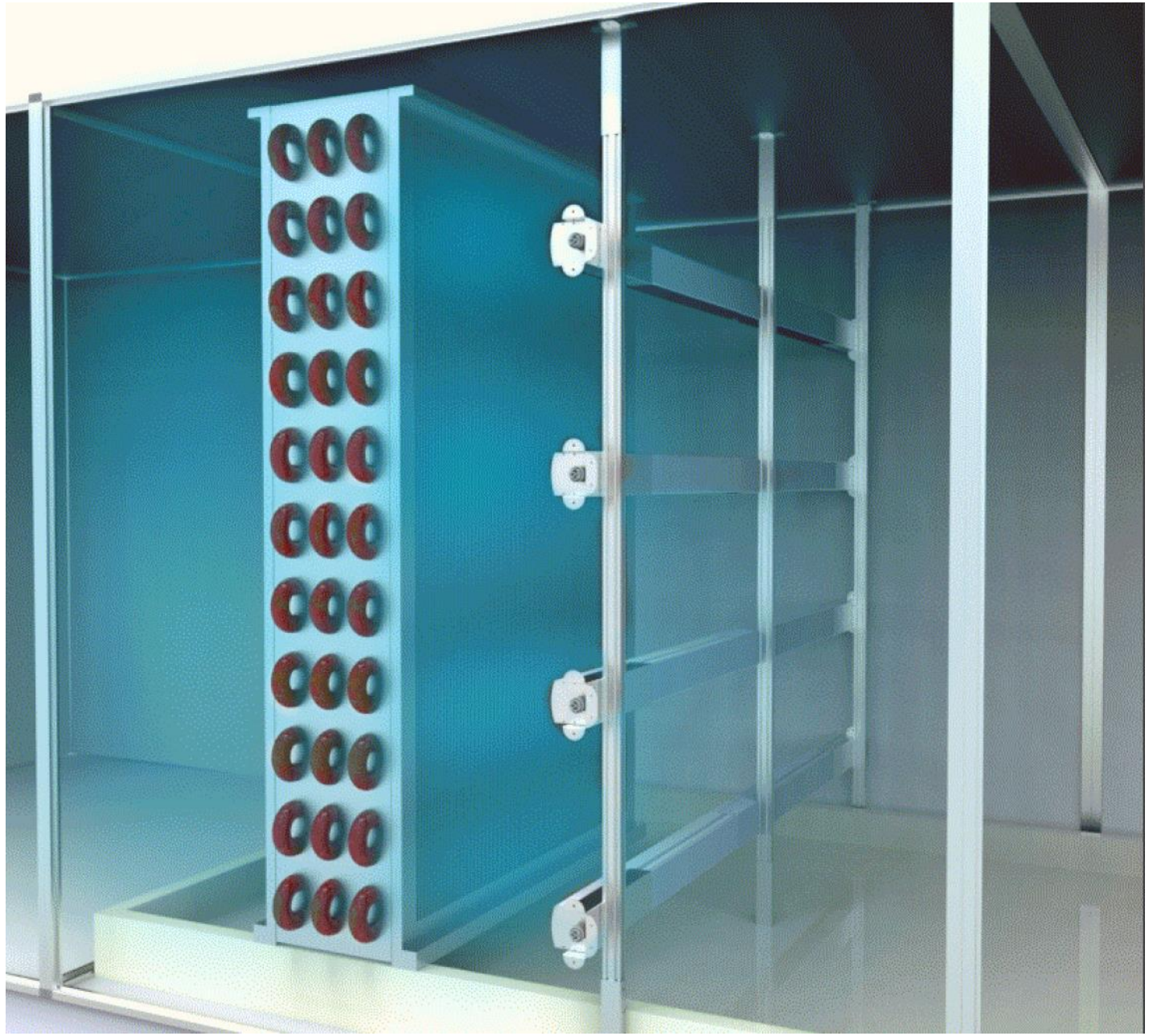
Specific for Coils treatment, it avoids settling and proliferation of Biofilm on the surfaces.

Special mirror bright reflector to increase UVGI power.

If sized correctly it can be used also to treat air at each passage.

Available in SS or Aluminum.

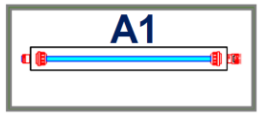
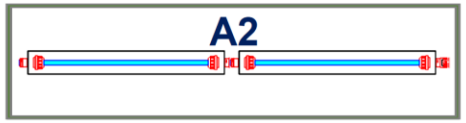
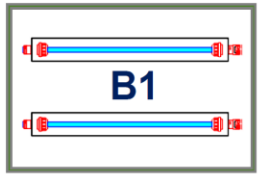
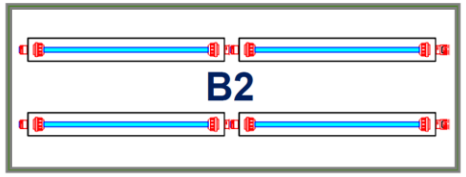
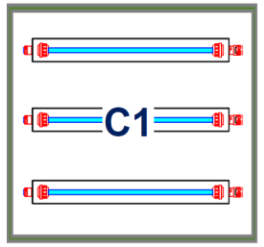
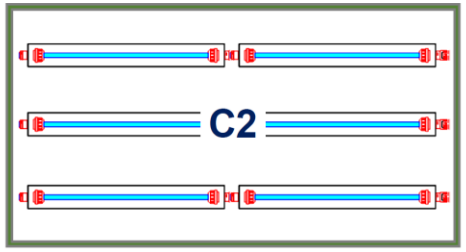
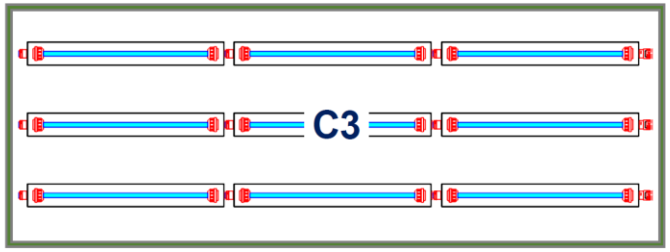
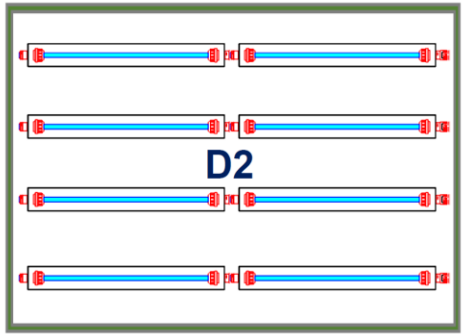
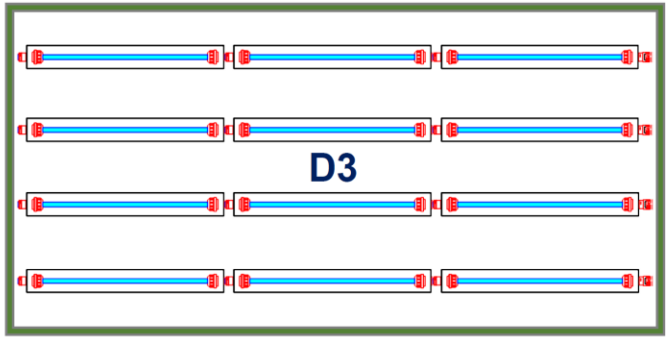
Ballast on-board.



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° FILE / Altezza (interna UTA) \ N° COLONNE / Larghezza (interna UTA)	1	2	3
A			
B			
C			
D			

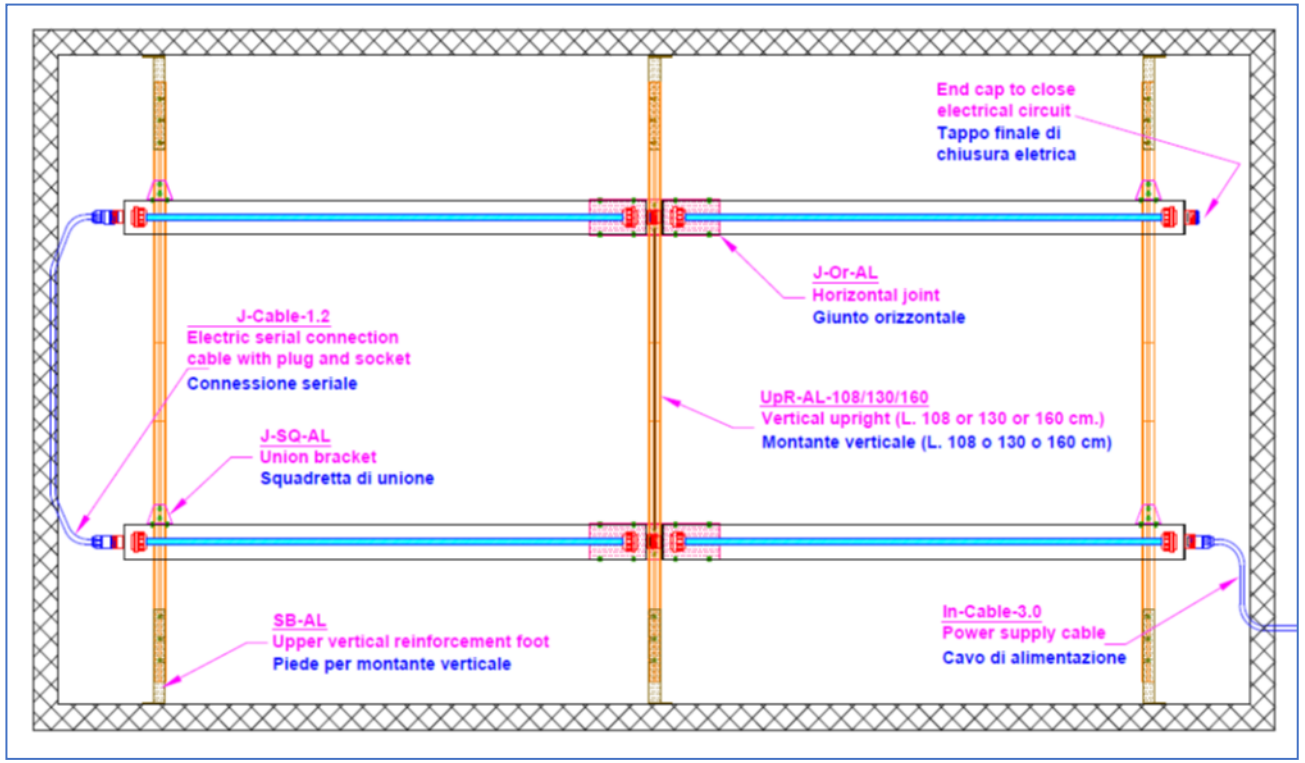
We designed 9 different **application layouts** to fit all common AHU sizes.

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

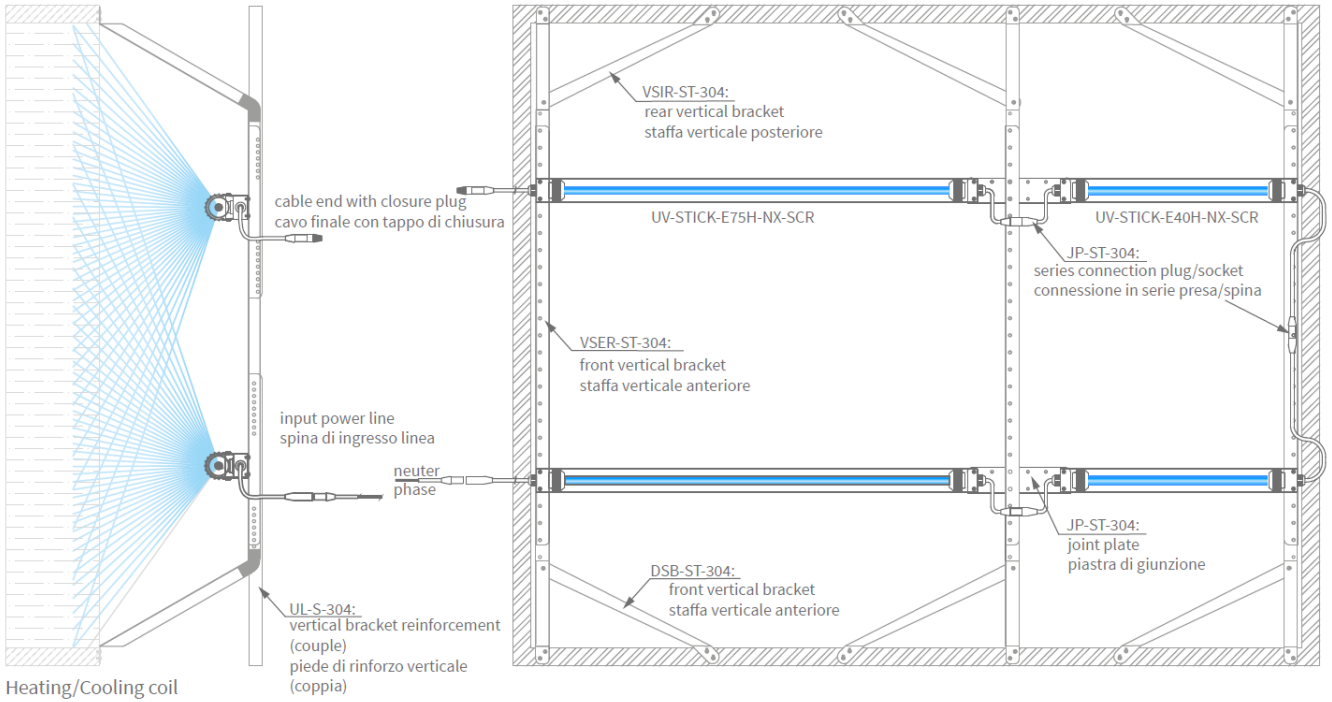
The 9 different kits have different options to fit the systems inside AHU's

On the AHU's wall

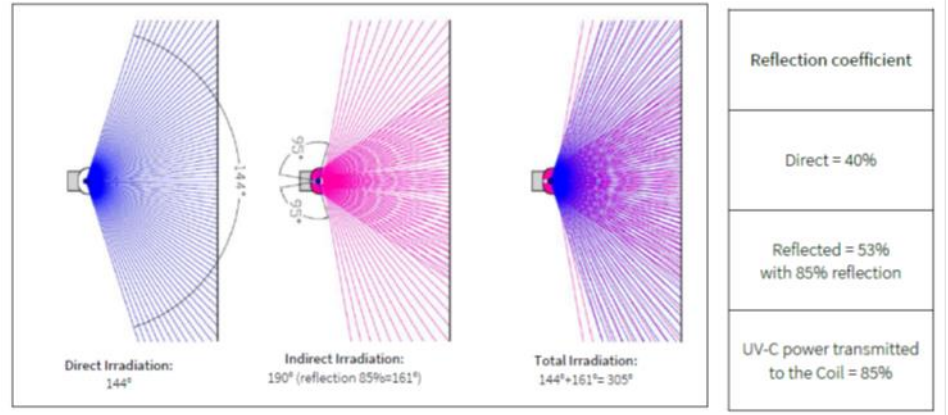
Mounting kit includes vertical uprights.
It is easier to apply at every stage of AHUs;
devices are linked inside the AHU only on floor and ceiling using adjustable feet.



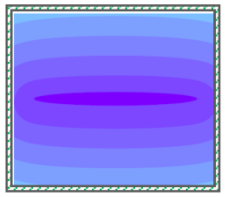
Directly on the coil frame =
This solution inlcudes less pieces, but the fixing is made directly on Coil frame, (sizes must be precise);



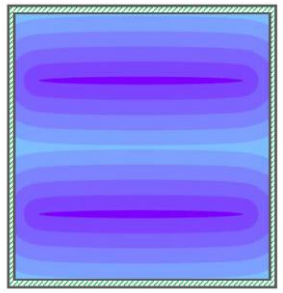
Reduction 99%		
	Aspergillus N.	Legionella Pn.
1	6 min.	12 s
2	7 min.	14 s
3	8 min.	16 s
4	9 min.	18 s
5	10 min.	20 s
6	11 min.	22 s
7	12 min.	24 s
8	13 min.	26 s



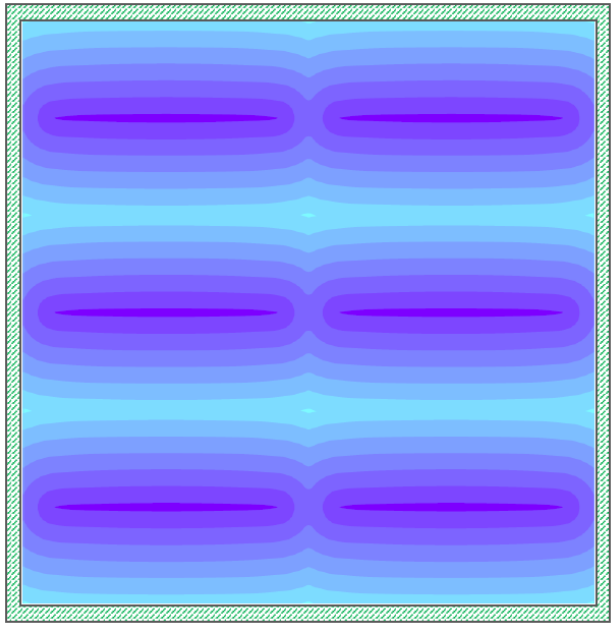
IRRADIATION MAP: this simple schema show you the distribution and intensity of UV-C rays toward the coil, even though you can reach 99% of microbial load reduction within seconds/minutes, always remember that UV light has to be always turned ON while Air Conditioning System is working!



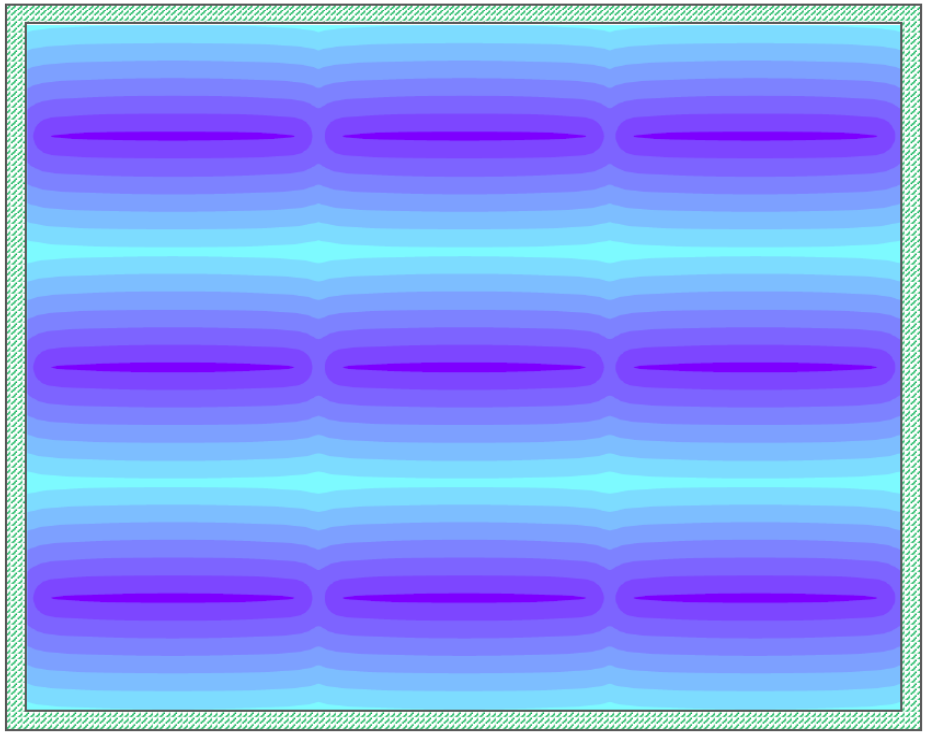
A 1



B 1



C 2



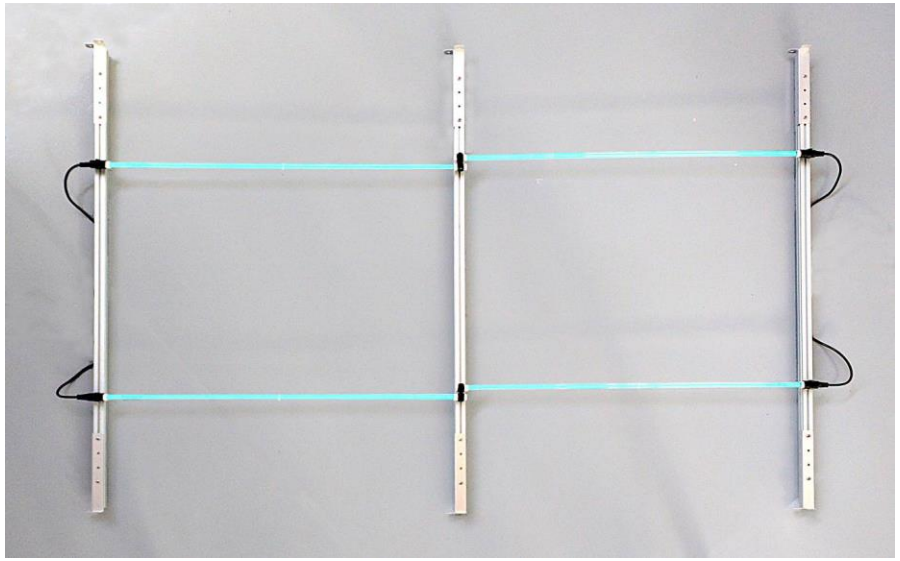
D 3

LIGHT PROGRESS

UV-FCU

NEW

UV-FCU + KIT
special application in AHU



UV-FCU
Fitted in a Fan Coil Unit

Simple and basic low cost system for AHUs, applicable also inside compact FAN COIL units.

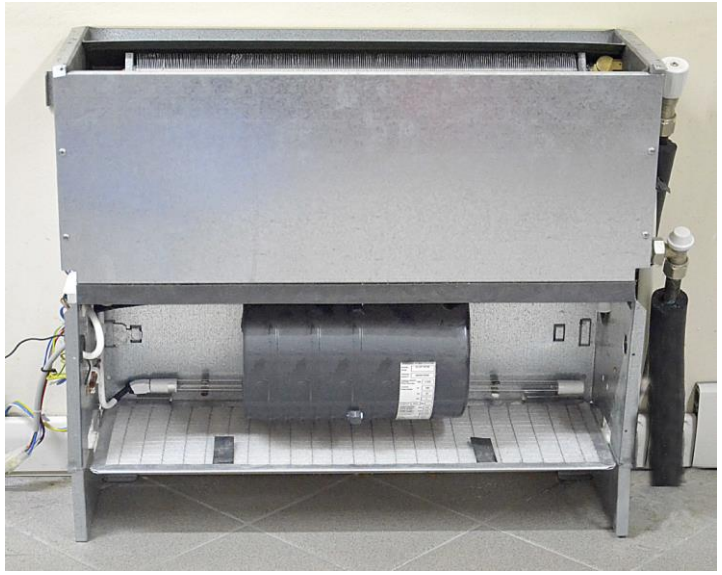
Each system includes lamp + ballast + clips.

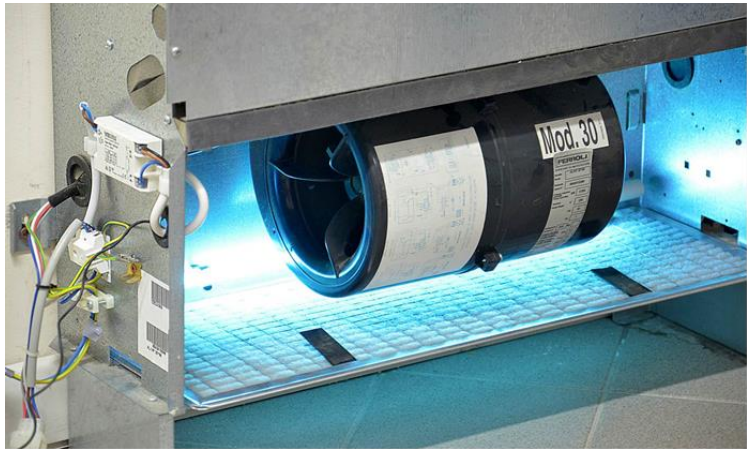
360° irradiation

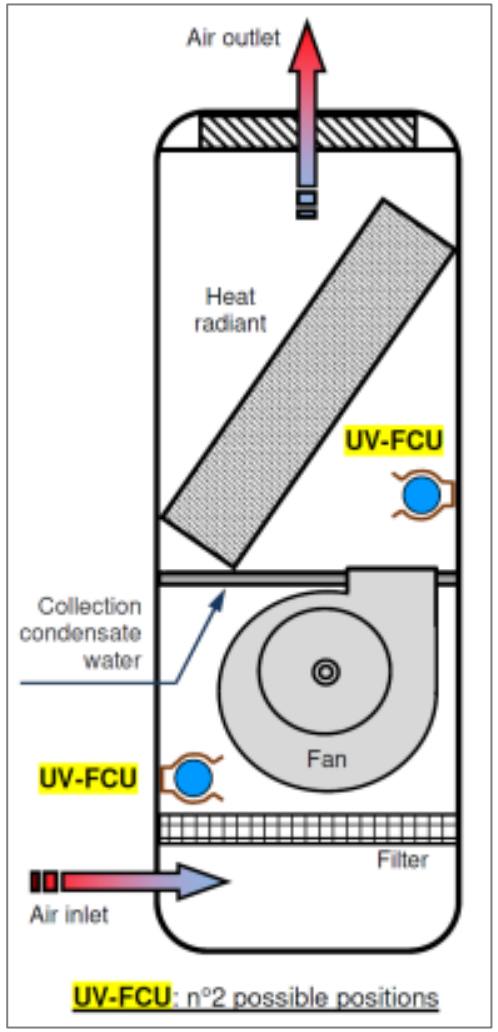
Available in many different length.

Ballast easy to link

CE RoHS 2002/95/EC

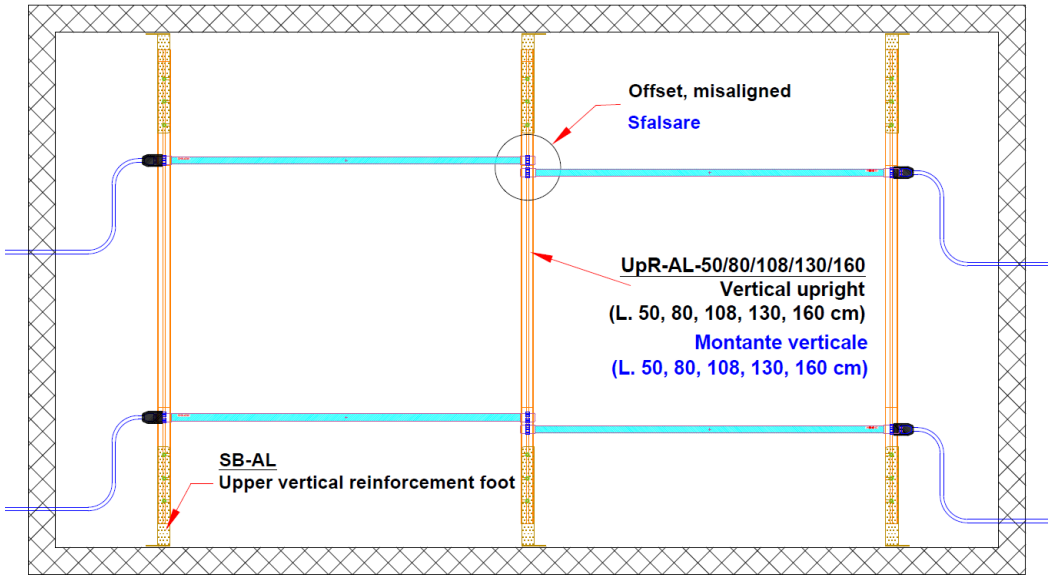


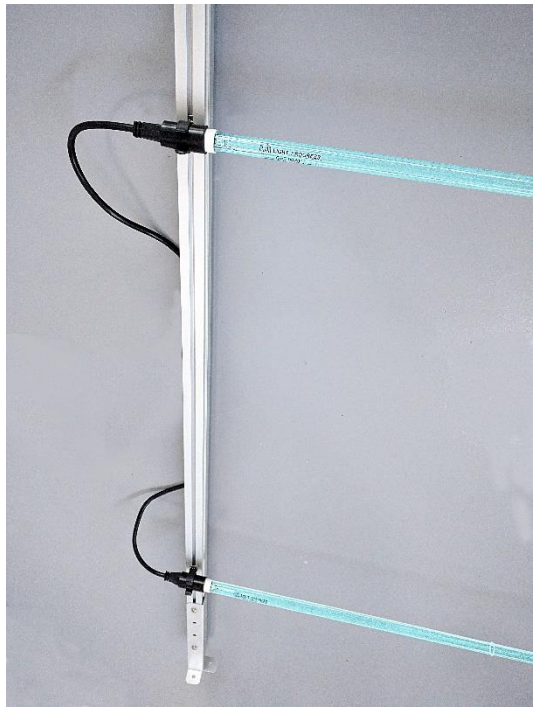




The perfect spot to apply UV-FCU-CL is the space between fan and heat/cooling battery.
The installation is easy, you can also apply it on fan already installed and working (retrofit on existing systems).

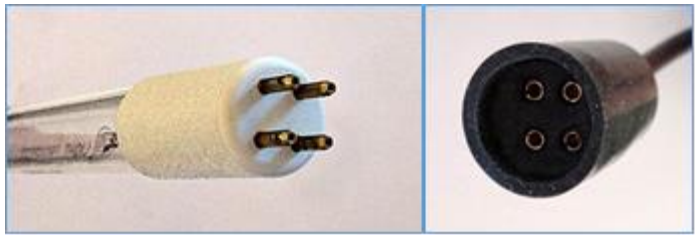
The power supply to power up the system is compact and is equipped with a special connection plug/socket that simplifies the lamp replacement. We suggest to apply it on the fan coil side and power it using the primary electrical connection used by the fan.

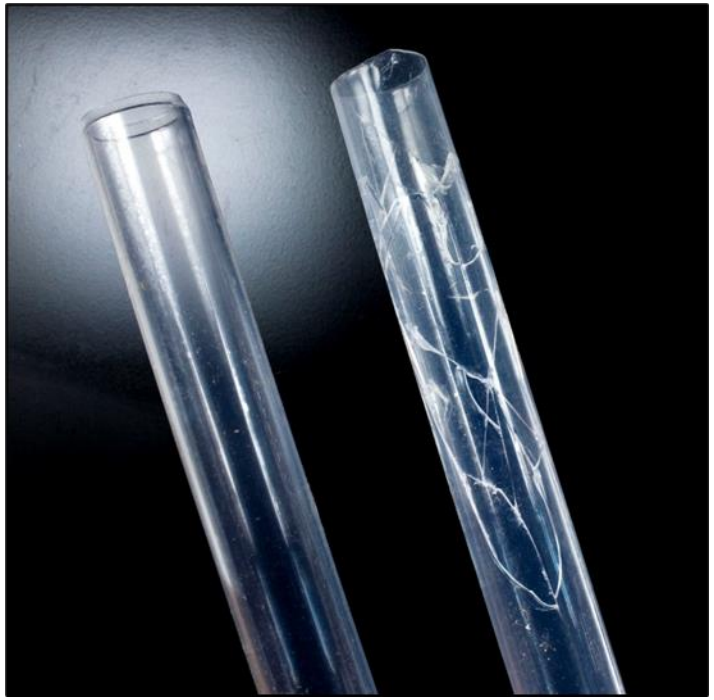




The easiest way to apply UV-C light inside AHU, a basic system to treat coil, filters and other internal surfaces inside AHUs.

Clips are provided with the system; in this way you can practically install the lamp on the mounting kit and then connect it through the quadri-pin plug to the ballast. Now you are ready to power up !





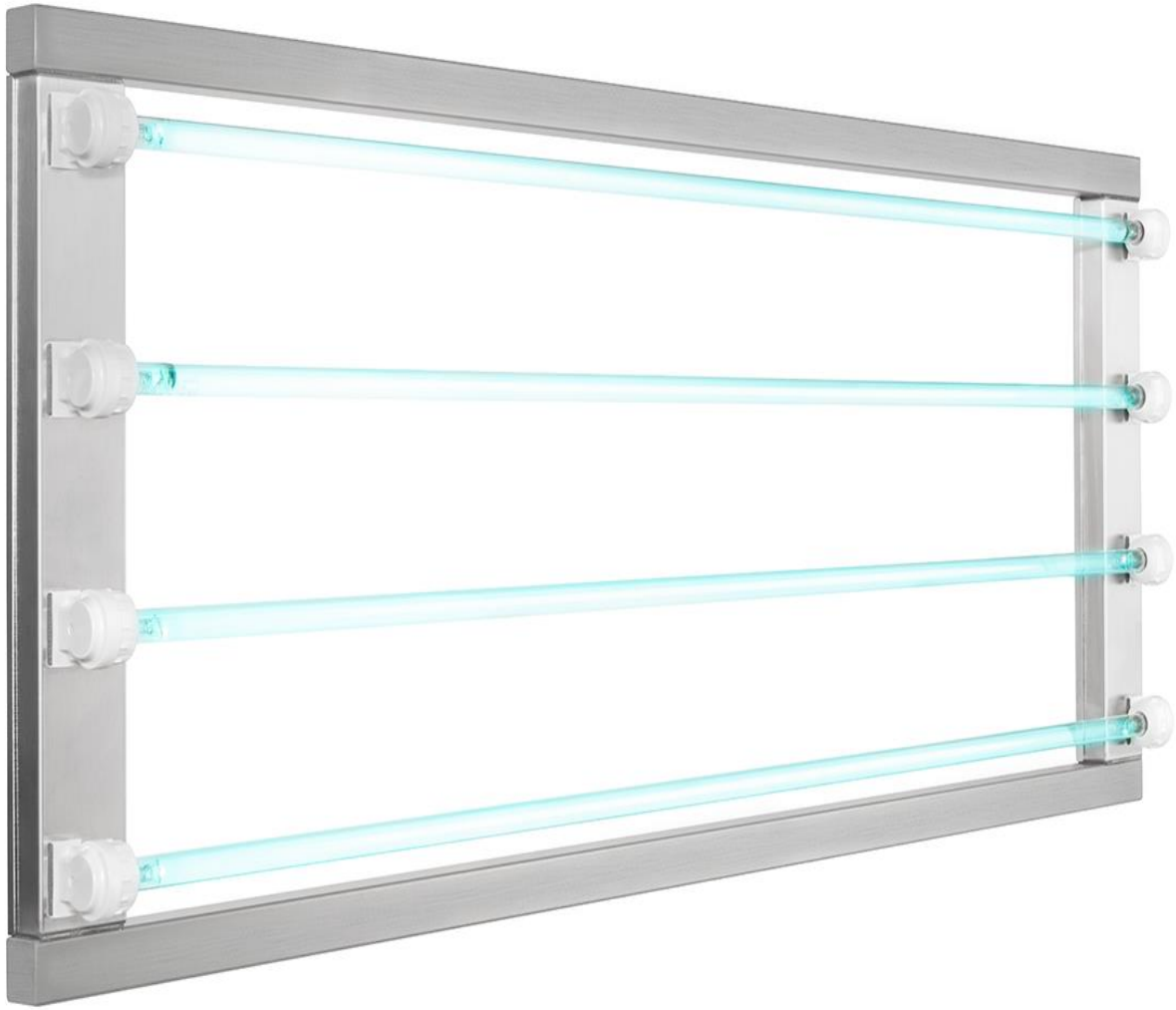
Special UVLON PIPE protection on the lamp to get IP44 protection grade

UVLON® is a Light Progress exclusive special FEP sleeve (Fluorinated Ethylene Propylene).

UV transparent, in case of breakings, it avoids glass fallings.

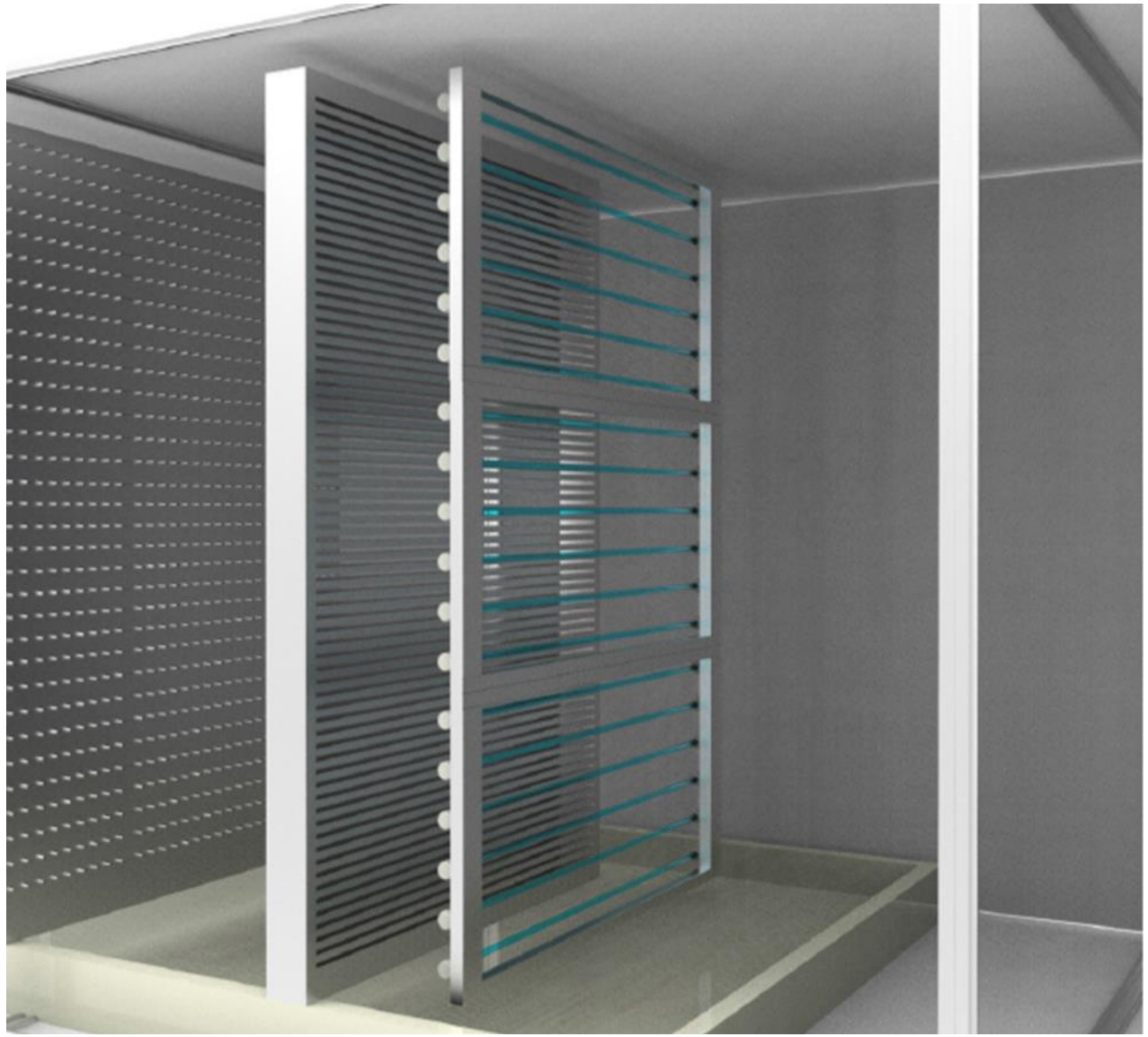
LIGHT PROGRESS

UV-DUCT-SQ



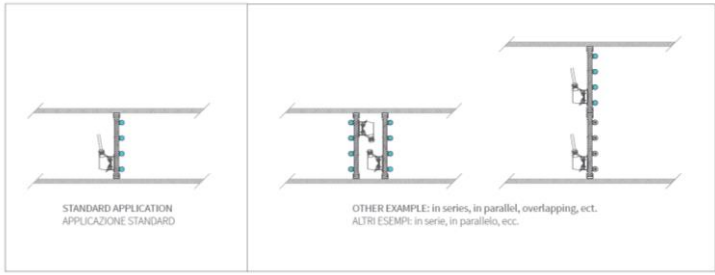
Square-grid device, the distance between lamps has been designed and can be sized to treat the air, beside internal surfaces constant disinfection.

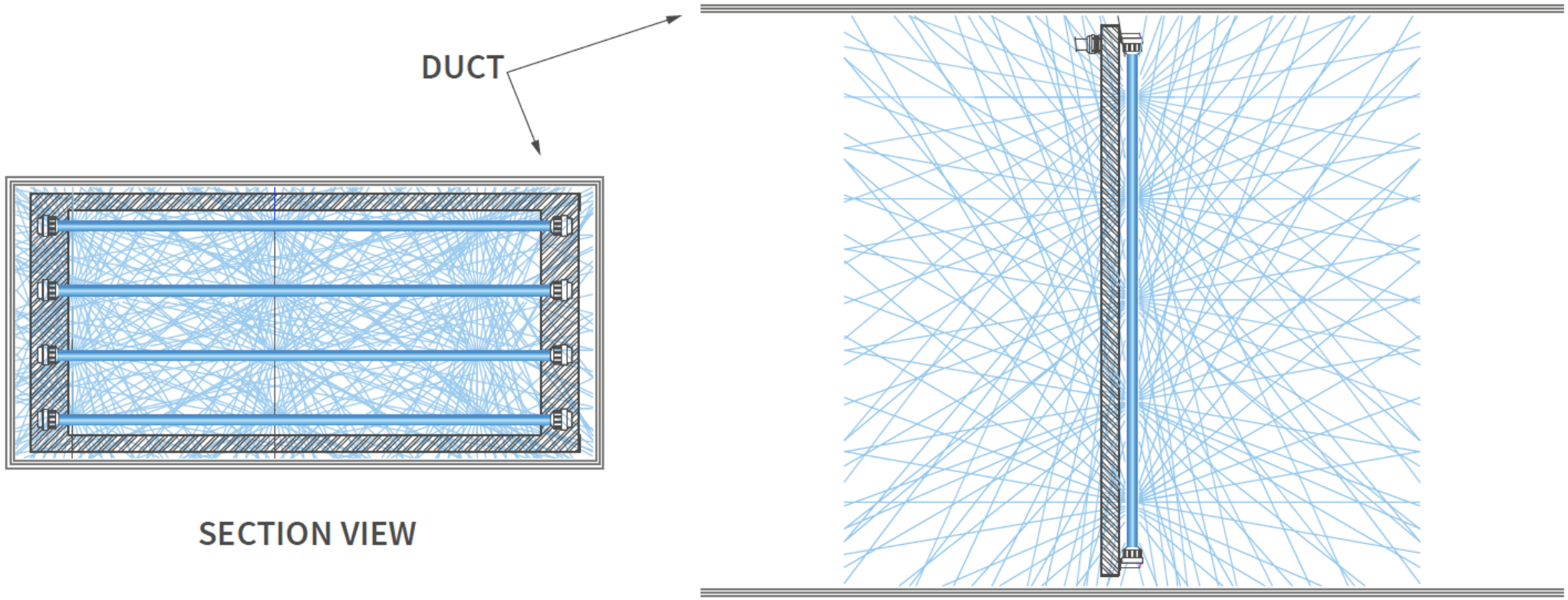
Signals and alarms can be checked on the control board, where ballast is also located.



UV-DUCT-SQ

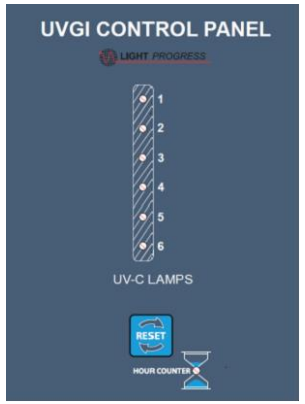
UV-DUCT-SQ has been designed to adapt to different sizes and ducts sections, placing one device to cover the surface or matching more devices together side-by-side, one on the other (overlapping), in series, etc. using scroll-in “U”profile, like filters or its original mounting kit with adjustable sizes.





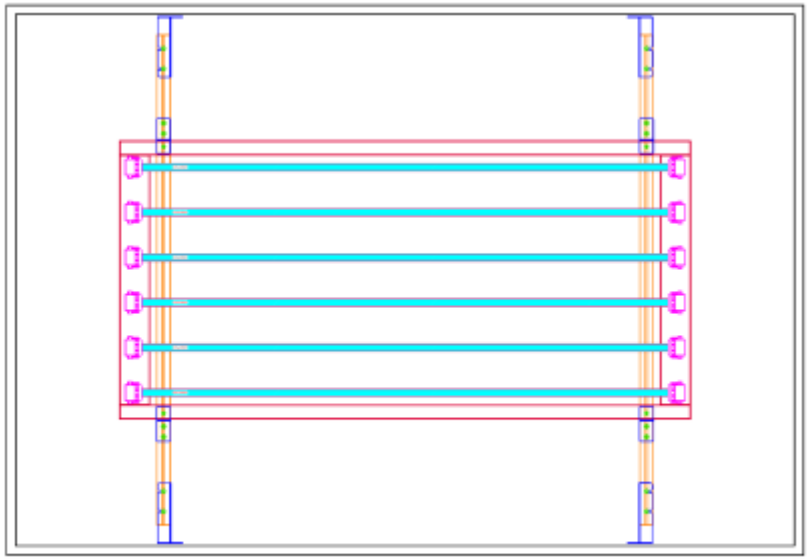
SECTION VIEW

TOP VIEW

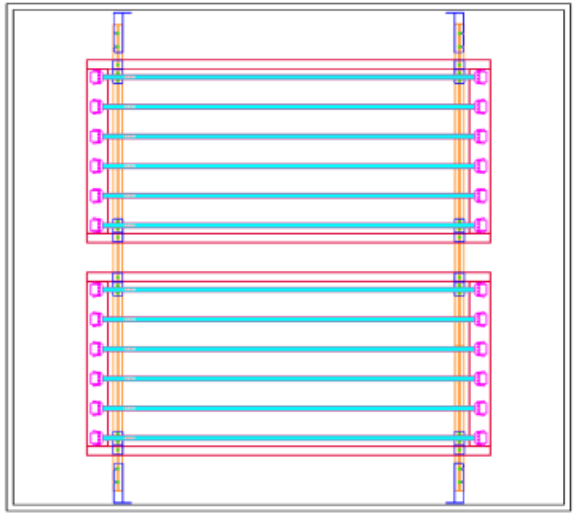


One device, endless solutions.

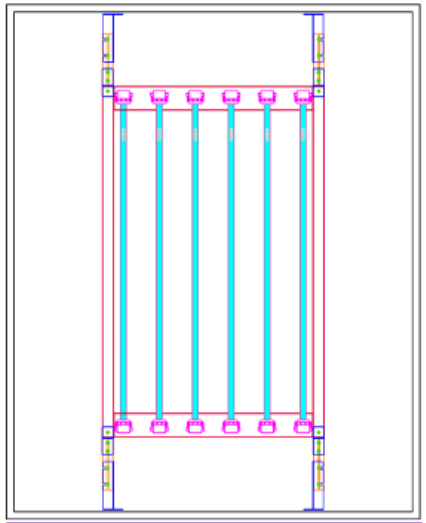
Simple control board to let you have all under control.



Mounting Example: n°1 UV Module placed horizontally



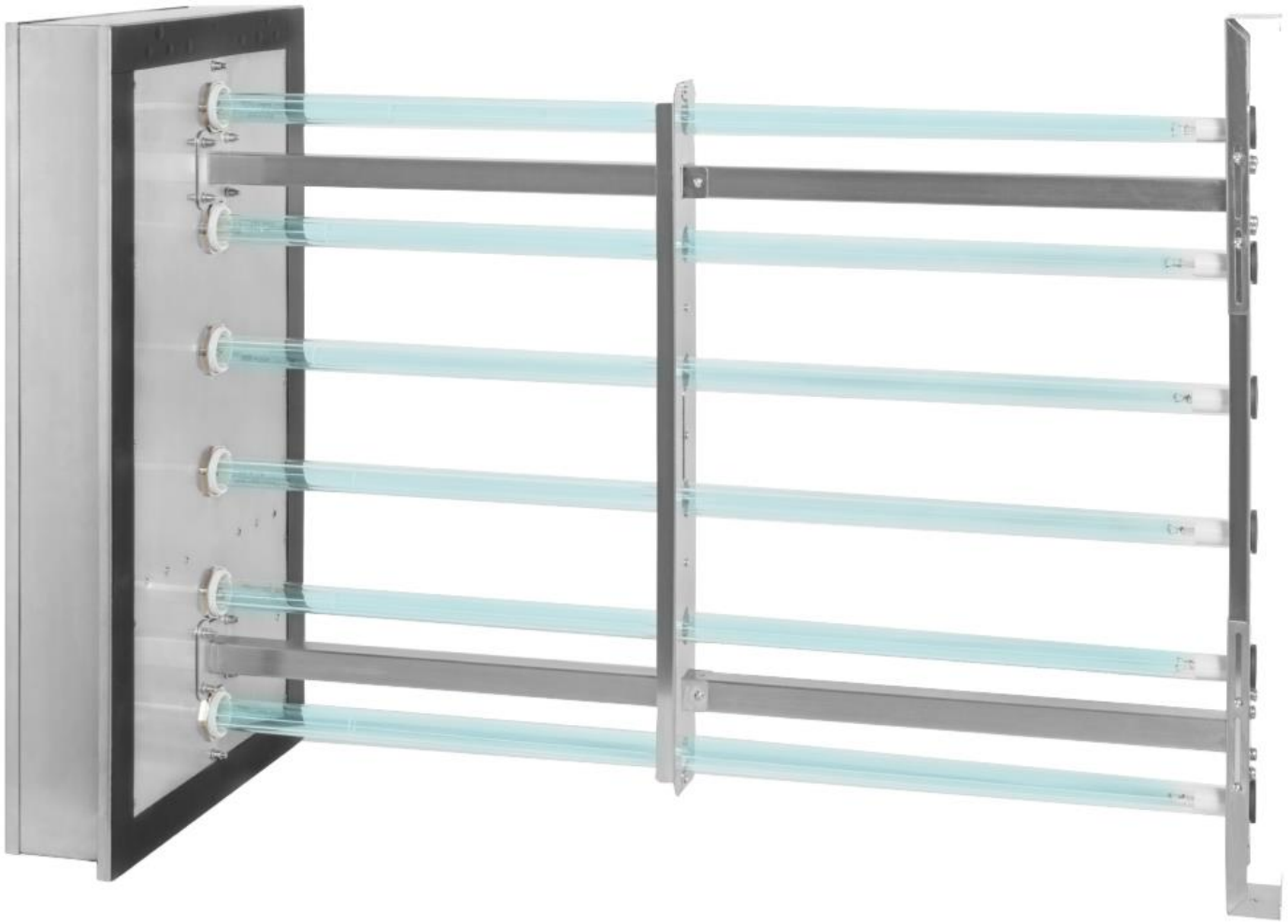
Ex.: n°2 UV Module placed horizontally one on top of the other



Ex.: N°1 UV Module placed vertically

LIGHT PROGRESS

UV-RACK



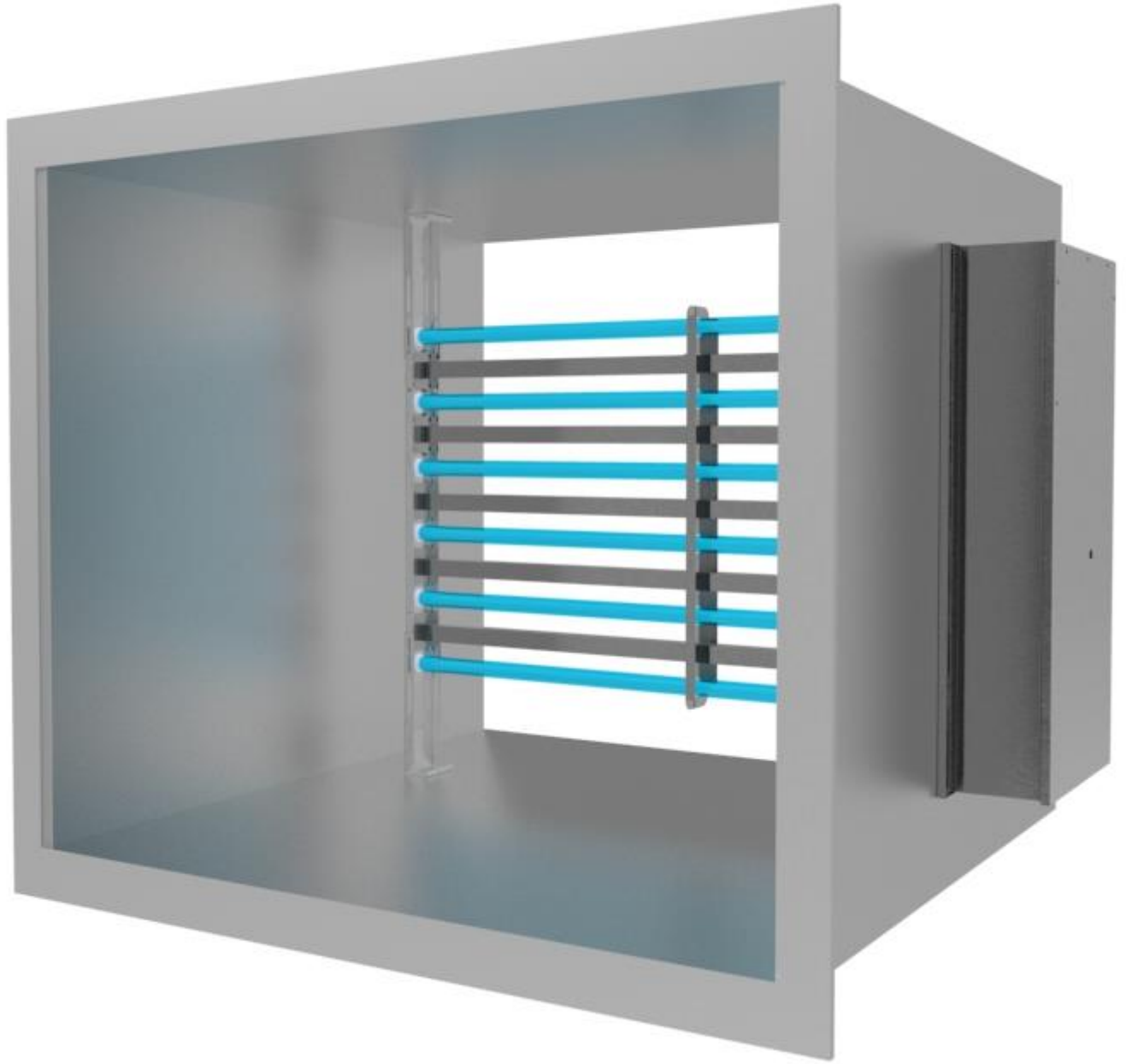
Designed for in-duct air treatment, it may be applied inside final AHU portion to sanitize surfaces, too.

Adjustable feet to fit duct sizes

Ballast on-board.

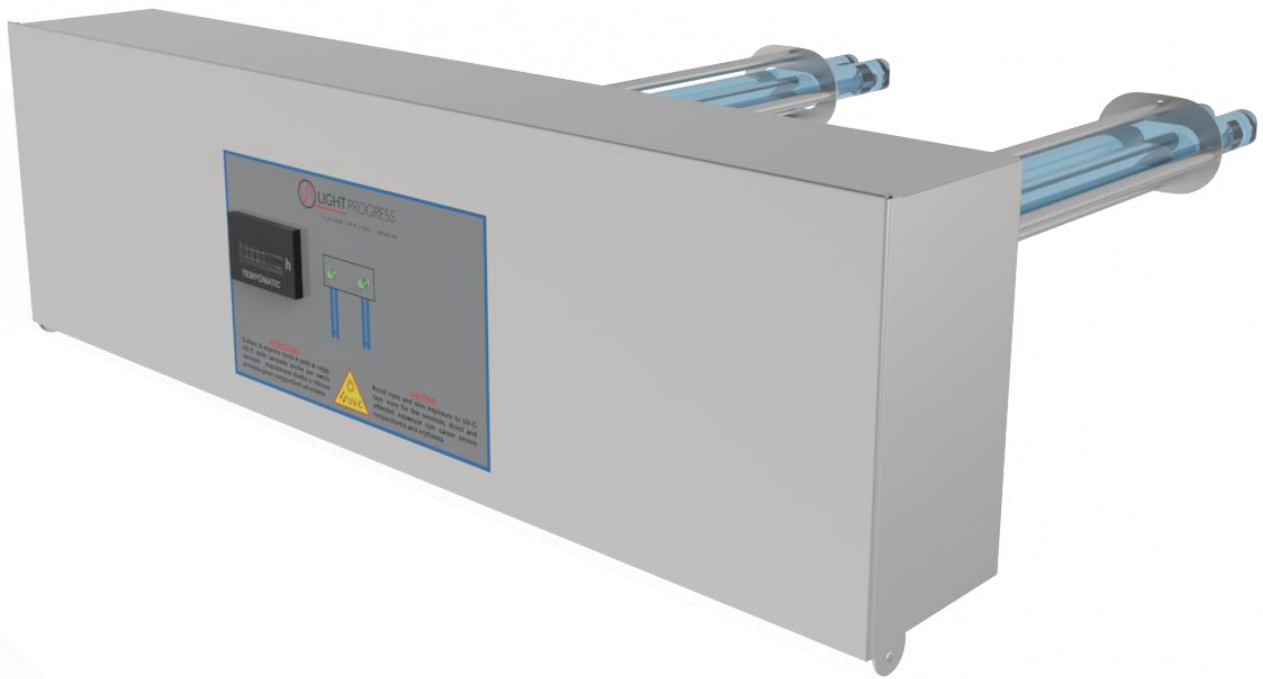
UV-RACK

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!



LIGHT PROGRESS

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.

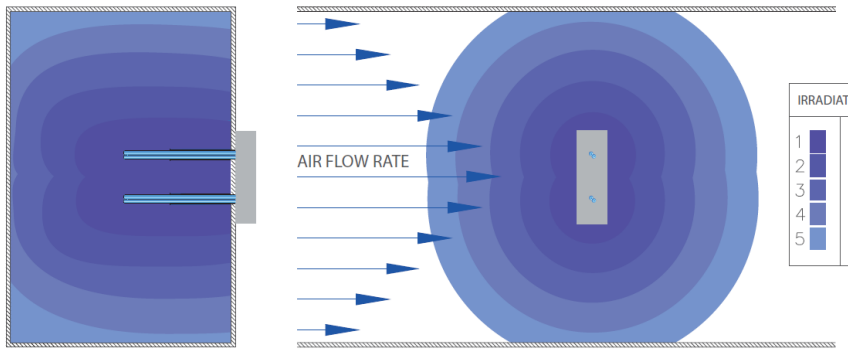
Ballast on-board.

CE RoHS 2002/95/EC

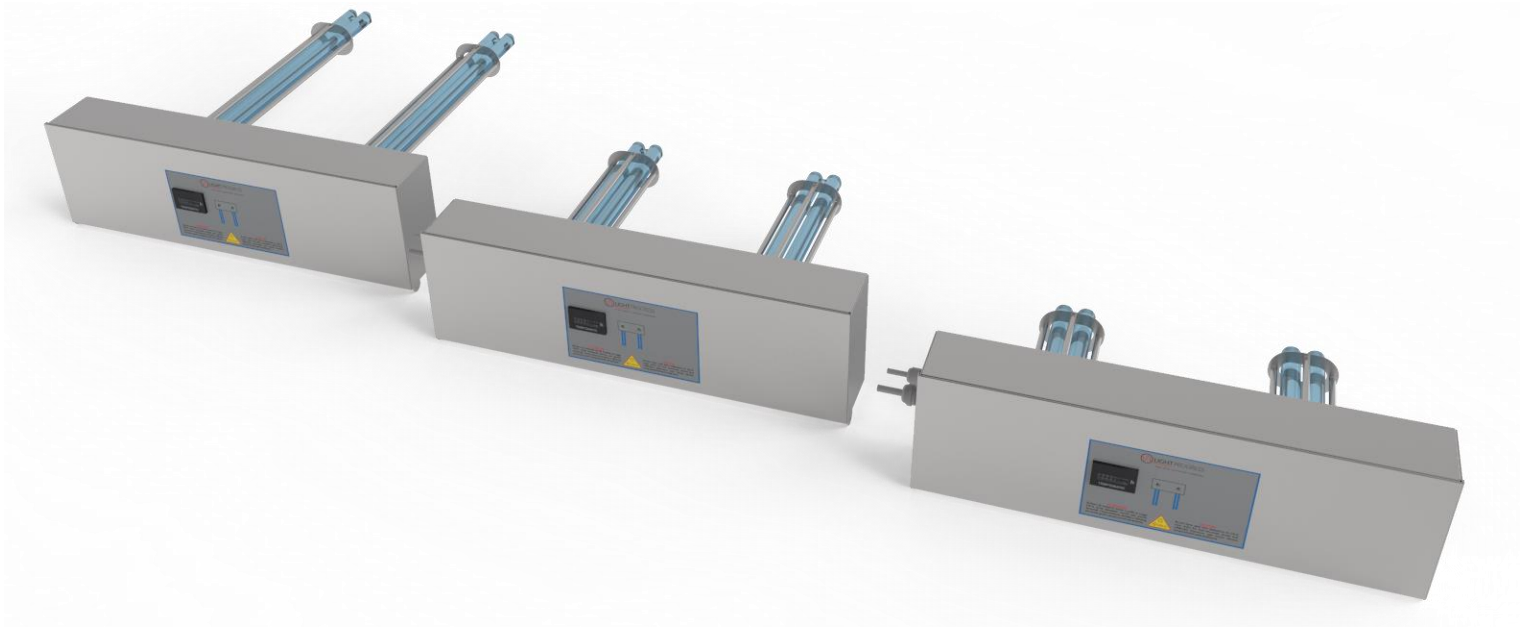
UV-DUCT-FL

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-DUCT-FL



Quick and easy installation, directly inside the air conditioning ducts.



LIGHT PROGRESS

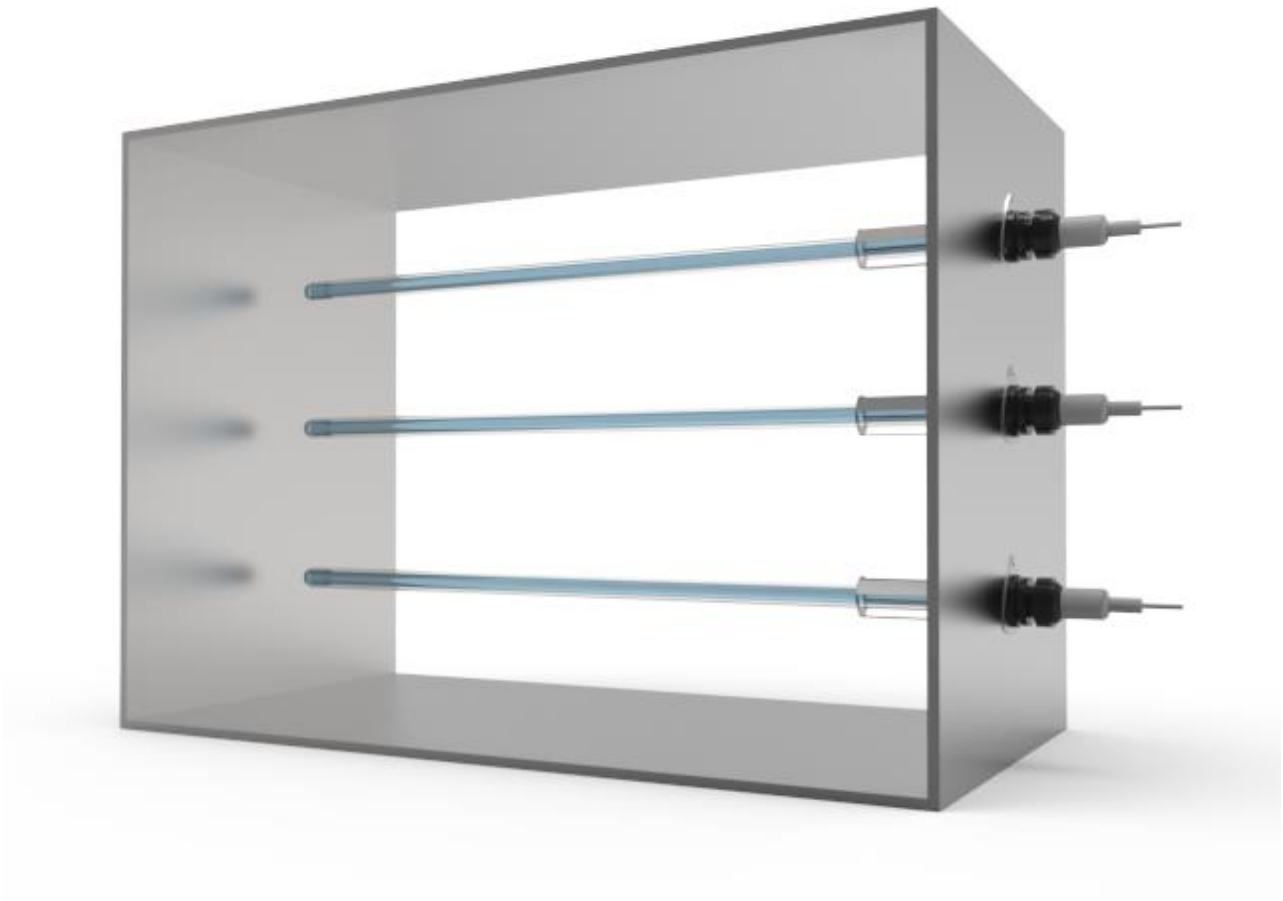
UV-STYLO-X

Simple lamp enclosed in a pure quartz sleeve, stainless steeel flange it can be applied anywhere.

Fits in small spaces, even for retrofit applications.

Separated power supply

CE RoHS 2002/95/EC

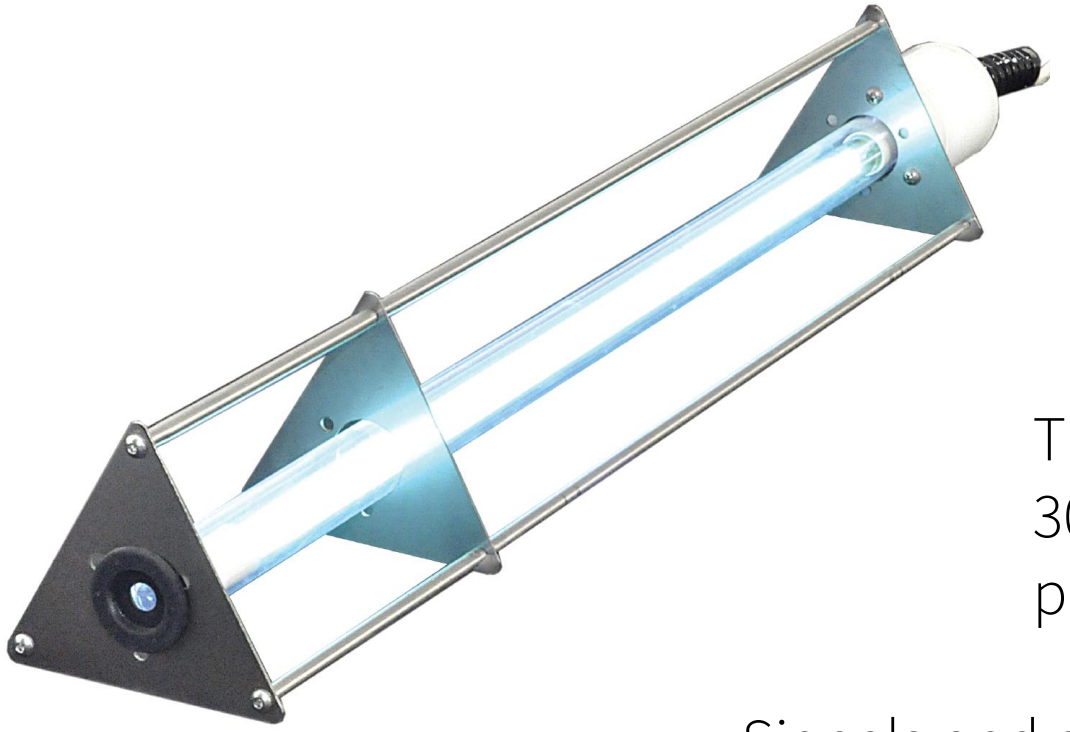


UV-STYLO-X

Its installation requires just a few simple steps, lamp replacement ad maintenance can be done without dismounting the system from the duct.
You can install as many as you want and create UV section in any AC system.

LIGHT PROGRESS

UV-STYLO-E

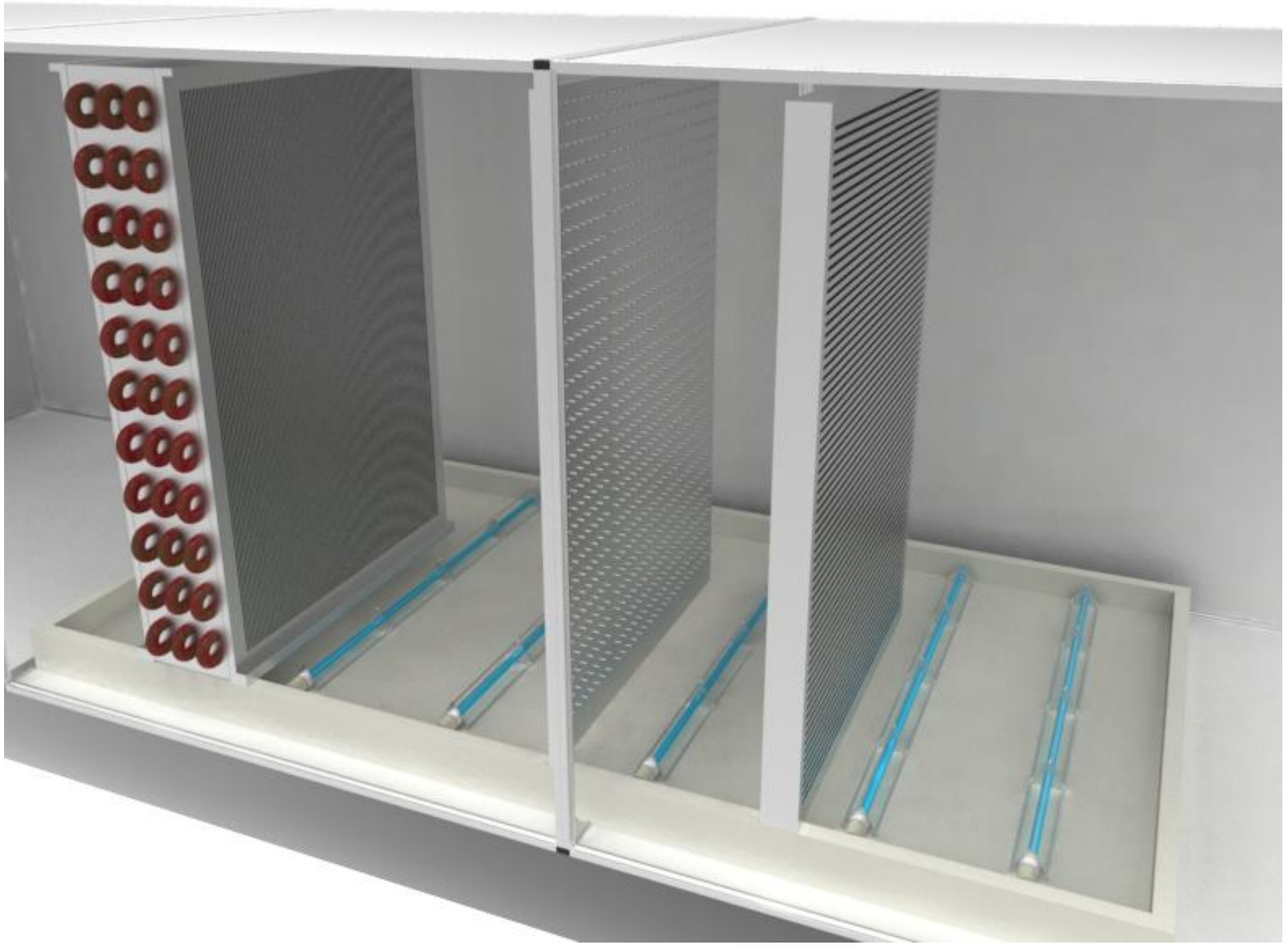


Installed inside the humidifier collection tanks submerging the device (up to 10 m) or under water splashes.

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.

CE RoHS 2002/95/EC



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*.

LIGHT PROGRESS

References


FAST
TRATTAMENTO DELL'ARIA


SABIANA


KLIMAK srl


LIGHT PROGRESS


CLIVET


MEKAR
AIR HANDLING UNITS


Zamil
Air Conditioners


robatherm
the air handling company


Lindab


LORAN


AERMEC


Carrier


Klimalco
climate experience


ClimaGold


RHOSS
CLIMA EVOLUTION


aisea
GROUP


euroclima
We care for better air


GEOCLIMA
Smart HVAC Solutions


HiDew
Dehumidifiers

Thank you