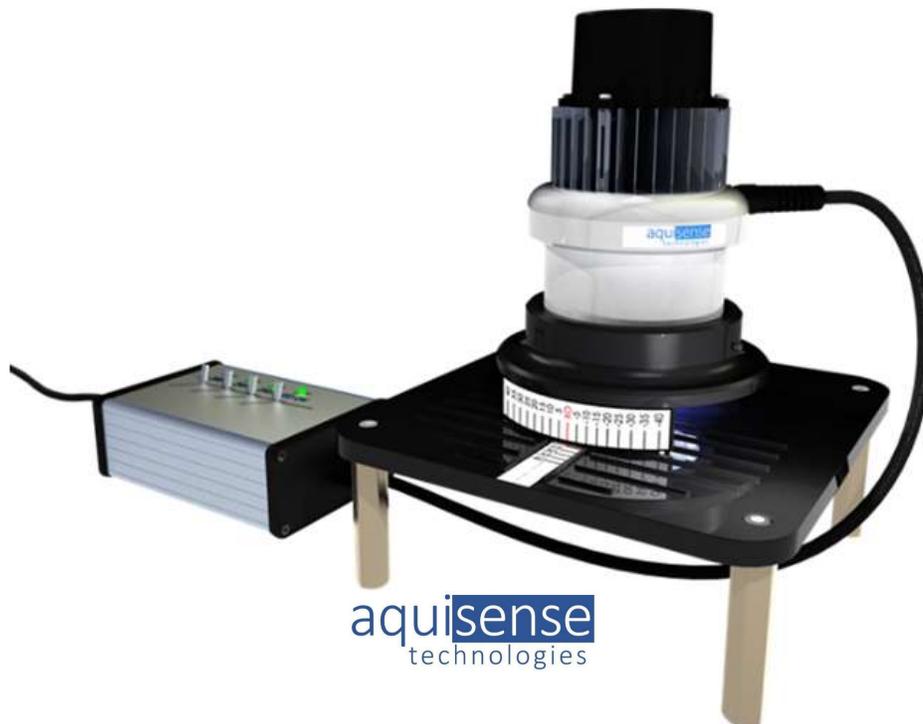


# PearlBeam™

## UV Instrumentation

- Collimated Beam for Bench Scale Research
- Up to 3 simultaneous UV wavelengths

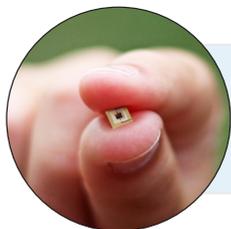


Boston Electronics  
91 Boylston St., Brookline, MA 02445  
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www.boselec.com  
617-566-3821

# Ultraviolet Solutions for Industry and Research

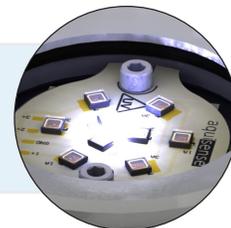
- **Deep UVLED** – high power, high reliability sources
- **UV Instrumentation** for Dose Response determination
- **UV Photodiodes and Sensors** – high reliability, high sensitivity SiC
- **UV Radiometers** – visualization and analysis of UV sensor data
- **UV Sensor Calibration Services** – PTB and NIST traceable





Utilizes small, state of the art UV-C LEDs which provide pathogen reduction without the use of harmful chemicals or mercury-based UV lamps.

Features UVinaire™: Replaceable UV LED lamp module with up to 3 selectable wavelengths. Stabilized UV output through advanced cooling design.



Optional Stage and Stand accessory allows for easy access to a petri dish as well as simple and repeatable petri dish factor measurement.

Optional UV Intensity sensor and radiometer allow measurement in the 250-400 nm range and provide data and trends.

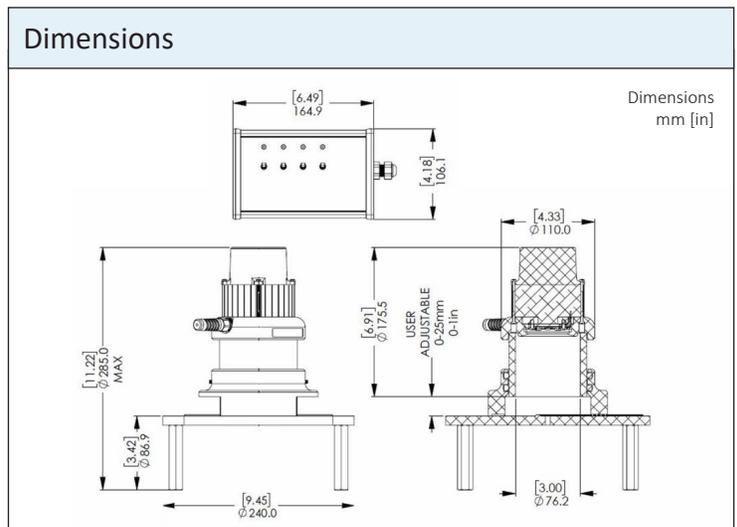
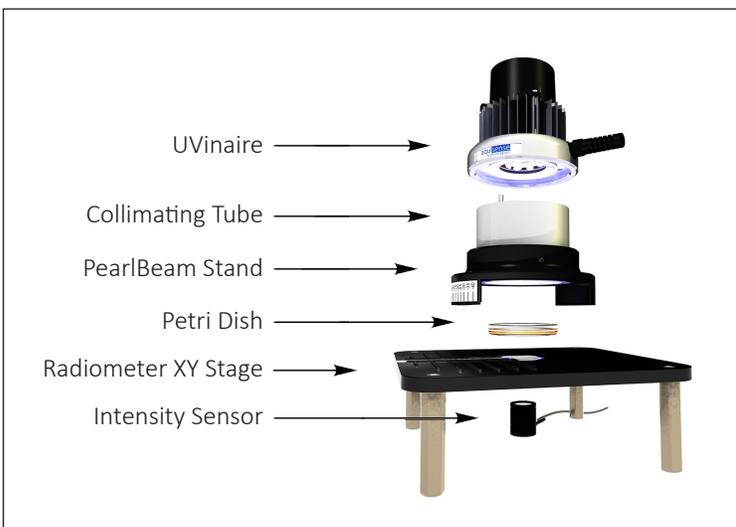


Applications include UV Dose response for liquids and surfaces, photopolymerization of materials, wavelength effect studies, and fluorescent slides.

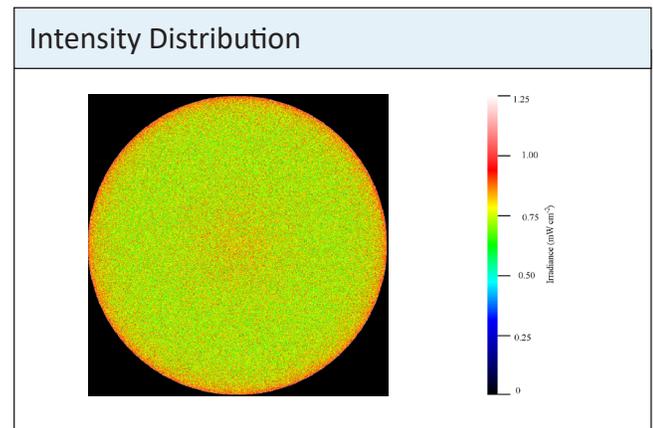
Features	
Ultra Small Footprint	Petri Dish Factor > 0.9
Instantaneous On/Off	Individual or Multiple Wavelengths
Unlimited Cycling	Suitable for Lab or Field Use
Mercury Free	Closed-Loop Thermal Management

Specifications	
Operating Temperature	0-35° C [32-95° F]
Lamp Life	Over 1,000 hours
Weight	Approx 1.6 kg [3.5 lbs]
Input Power	110-240 AC Power Supply

Accessories		
Stage and Stand	Intensity Sensor & Radiometer	Carrying Case



Model Number**	Wavelength (nm)	Irradiance* (mW/cm <sup>2</sup> )
S255	255	0.05
S285	285	0.7
D255/285	255 & 285	0.05 & 0.7
T255/265/285	255, 265, & 285	0.05, 0.3, & 0.7
T265/285/300	265, 285, & 300	0.3, 0.7, & 0.7
T285/300/365	285, 300, & 365	0.7, 0.7, & 13



\*Irradiance is measured at the bottom of the collimating tube.

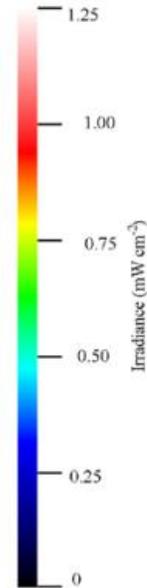
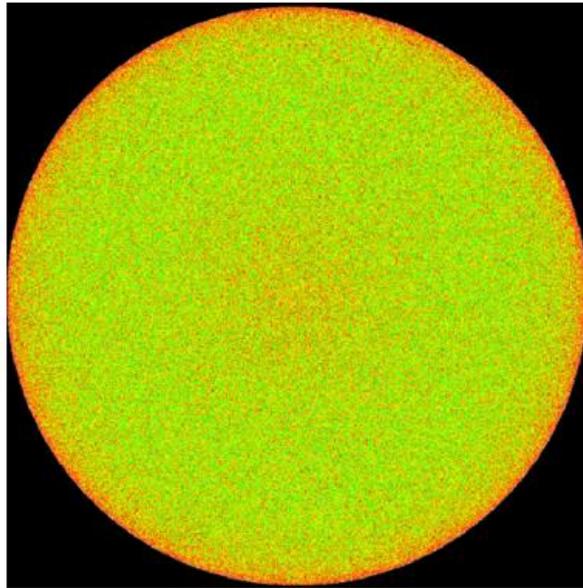
\*\*Custom PearlBeams are available. Please contact us for details.



## Introduction

The PearlBeam offers researchers the ability to conduct Ultraviolet (UV) light studies to develop UV Dose curves on liquids and surfaces, to easily perform wavelength dependent studies, along with many other applications. This document describes several options to add analysis benefits to researchers. The stage and stand allow precision in placement of the PearlBeam and includes an option for sensor mounting. Sensors under the PearlBeam offer data to track wavelength and intensity. The radiometer is a handheld device that tracks the sensor data for instant analysis of UV intensity.

## Intensity Distribution

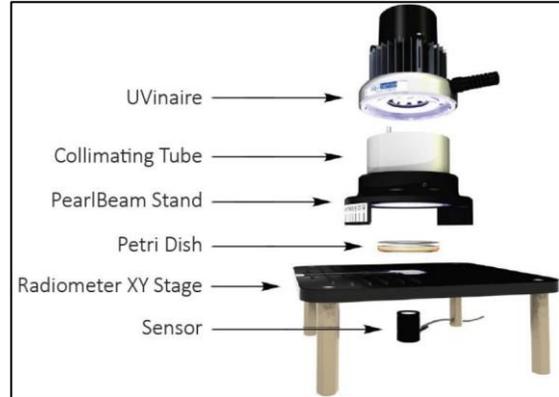


According to the protocol developed by [Bolton and Linden \(2003\)](#), a Petri Factor is defined as the ratio of the average of the incident irradiance over the area of the Petri dish to the irradiance at the center of the dish. This allows a user to more accurately determine the average fluence rate of the collimating beam.

A Petri Factor greater than 0.9 helps to ensure all the area under a collimating beam is treated with an even intensity of UV-C light. This can be calculated by measuring the irradiance with a radiometer and sensor every 5 mm over the area of the collimating tube.

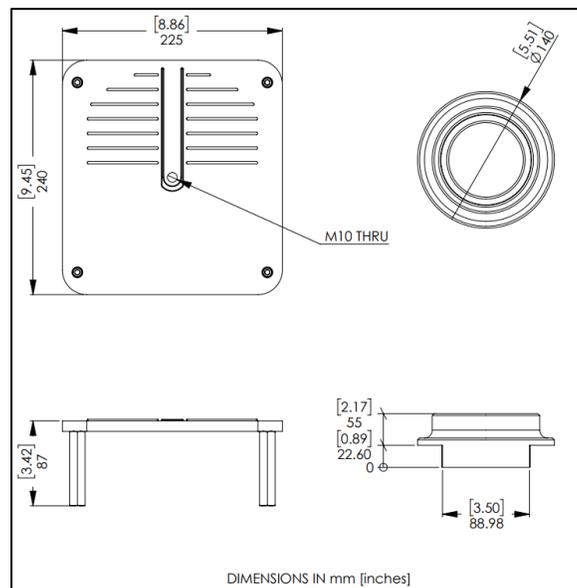
Each PearlBeam is tested to ensure an even intensity distribution. When ordered with a radiometer and sensor, the Petri Factor for your PearlBeam is measured with the same devices you will receive ensuring results specific to your device and accessories.

## Stage and Stand



The Stage and Stand option allows for a convenient work space to use your PearlBeam device. The Stage occupies a small footprint and allows the user to anchor an optical sensor. At the center of the Stage is an 8mm sensor port. This hole can be expanded with a drill bit to fit the optical sensor of your choosing.

In addition to providing a work space, the Stage and Stand also allows the user to accurately determine a Petri Factor with ease. The underside of the Stand fits securely on to the Stage with interlocking grooves. This enables the movement of the PearlBeam in 5mm increments in both the X and Y planes for Petri Factor calculation. On either side of the Stand are openings allowing easy sample placement and removal.



## Radiometer/Light Meter



**InternationalLight**  
TECHNOLOGIES



AquiSense Technologies is able to supply the ILT2400 Hand-Held Light Meter by [International Light Technologies](http://www.international-light.com). It's one of the most advanced devices of its kind on the market today. ILT's Accuspan software automatically sets the averaging while rapidly measuring over 8 decades of light intensities. The internal software allows customers to capture a peak as brief as 100 $\mu$ s and to store up to 16 readings per second. The color display works in both landscape and portrait mode.

- Research Quality at a Hand-held Price
- 8 Decade Dynamic Range of Optical Analysis
- Meter & Sensors with NIST Traceable ISO17025 Accredited Calibration
- Hand-held, Compact, Ergonomic Design
- Brilliant 4.3" Touch Screen Display
- 90° Screen Rotation for Landscape and Portrait Viewing
- ILT's Accuspan: Auto-ranging with Smart Averaging
- Built-in Rechargeable Battery Lasts Up to 8 Hours
- Backwards Compatible with ILT1700 Sensors
- Measurement Speeds Up to 100  $\mu$ Seconds

ILT2400 optical measurement systems include an ILT2400, carrying case, software and customer configured detector/filter/optic and calibration. ILT2400 optical measurement systems allow direct reading in the appropriate empirical units including; lux, foot-candles, candela, lumens, watts, W/cm<sup>2</sup>, cd/m<sup>2</sup>, foot-lamberts, nits, etc. The ILT2400 and software are compatible with most Windows 7 and Windows 8 computers.

- **Measurement Range:** 50pA – 1mA current, 8 decades of light intensity measurements
- **Screen:** 4.3" VGA Capacitive touch screen color display
- **Bias:** 5V Reverse Bias
- **Ranging and Averaging:** Automatic
- **Internal Memory:** 4 GB
- **Operating Temperature:** 0-40o C
- **USB:** Micro for data download
- **USB:** Mini for charging and remote data logging using DataLight II PC software
- **Size:** 1-3/5" H x 3" W x 6" L
- **Detector/Sensor connector:** 15 pin connector
- **CE certified:** No RF noise

## Sensors



AquiSense Technologies is also able to supply the SED005 and SED270 optical sensors by International Light Technologies. Both models are compatible with the ILT2400 light meter. ILT detectors are designed to emit low levels of current in the pico-amp to milli-amp range which is then converted to calibrated optical units such as lux, W, W/cm<sup>2</sup>, etc., when used with ILT light meters. Detector assemblies typically include a sensor, filter, optics and calibration.

Example of a calibrated detector assembly for lux: "SED033/Y/W" includes the "SED033" 33mm<sup>2</sup> silicon photodiode detector, the "Y" photopic correction filter with the "W" Diffuser and calibration. (Note: "/U" indicates an uncalibrated sensor).

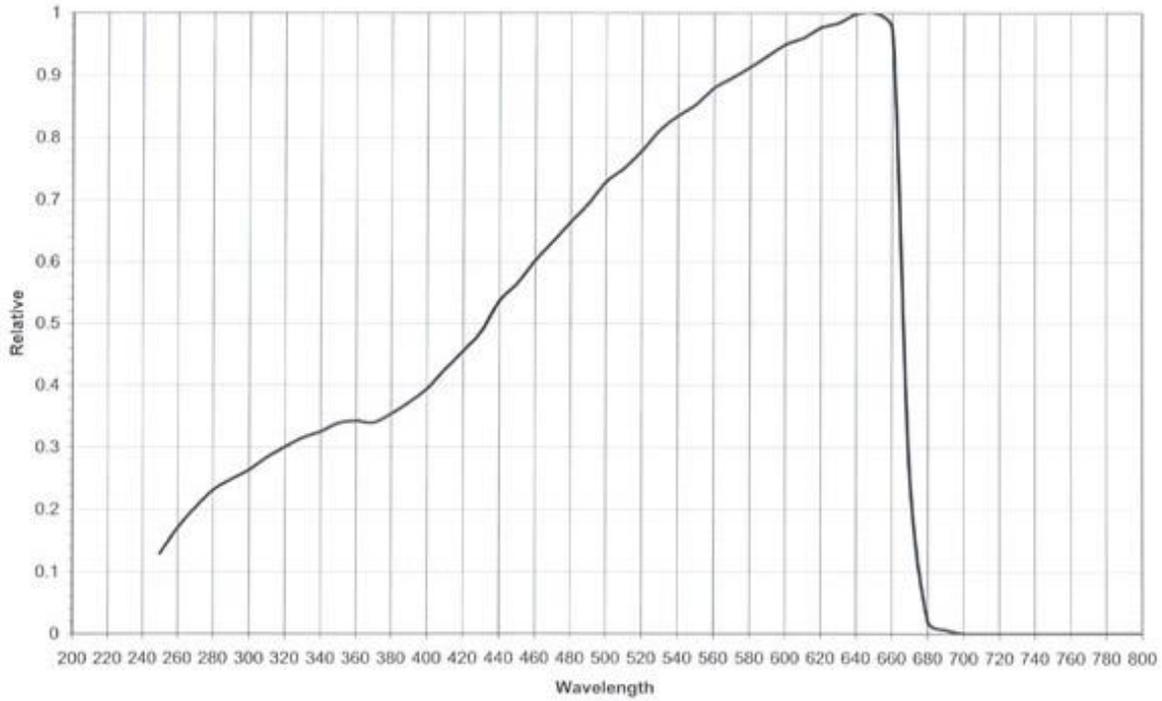
Optical sensors have a black anodized aluminum housing. Diameter is 42mm (48mm with sensor cover). They come with diffuser (5mm aperture) and a 2-meter cable.

The SED type optical detector housing is made of black anodized aluminum, with a female filter thread (1¼-24), and two end mounts (#8-32).

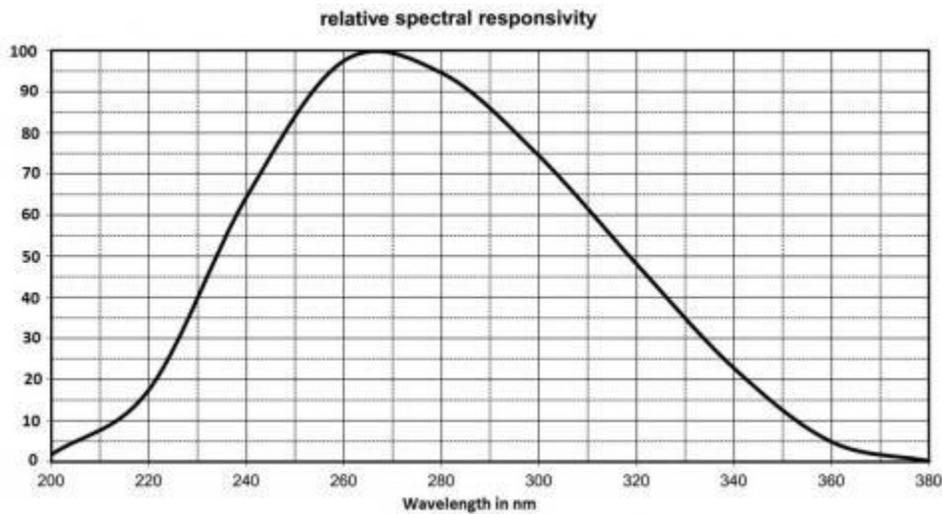
SED005	250-675 nm, 610 nm peak	5.2 mm <sup>2</sup> detector with quartz window. Dimensions: 29 x 42 mm dia. UNCALIBRATED.
SED270	215-355 nm, 265-270 nm peak	2 mm <sup>2</sup> active area SiC photodiode (visible blocking). Dimensions: 29 x 42 mm dia. UNCALIBRATED.

## Response Curves

### SED005



### SED270

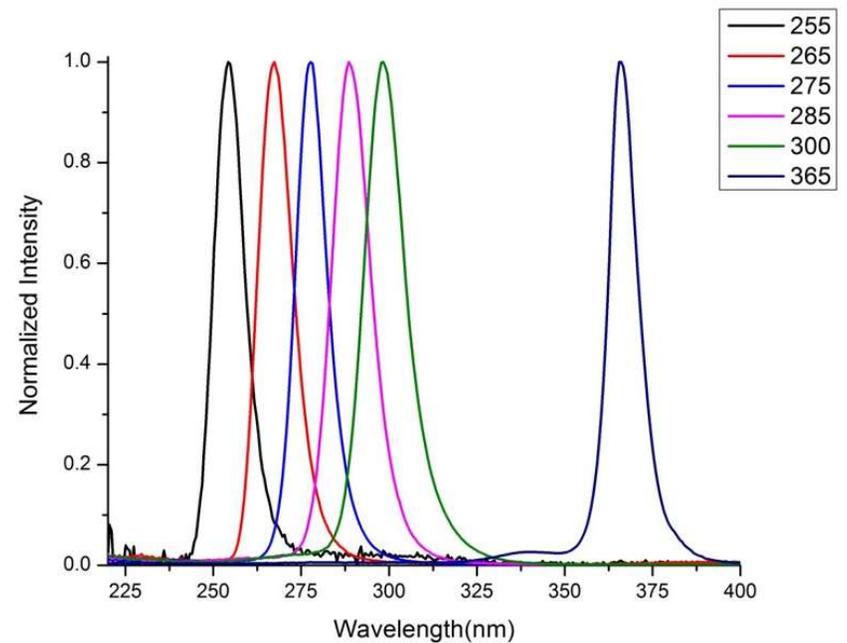


# **PearlBeam Instrument Notes**

- **Collimated Beams**
- **Dose Response Curve**
  - **Petri Factor**

# Collimated Beams – What are they used for?

- Applications include
  - **UV Dose response for organisms**
  - Photopolymerization of materials
  - Wavelength effect studies
  - Fluorescent slides



# Collimated Beams and UV Dose

$$\text{UV DOSE} = \text{INTENSITY} \times \text{RESIDENCE TIME}$$



How much UV light is being “dosed” into a reactor or onto a sample

How much energy the light source (*collimated beam*) is providing



The length of exposure time to the energy

## UV Dose is expressed in:

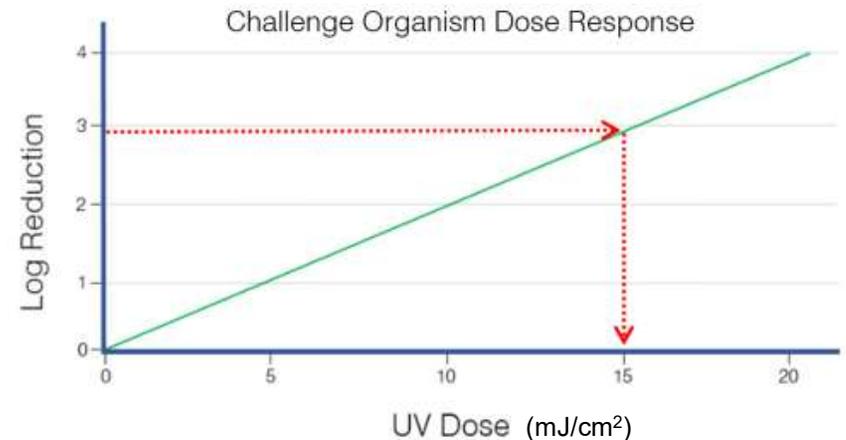
- $\mu\text{Wsec}/\text{cm}^2$  (Microwatt seconds/ $\text{cm}^2$ )
- $\text{mWsec}/\text{cm}^2$  (Milliwatt seconds/ $\text{cm}^2$ )
- **$\text{mJ}/\text{cm}^2$  (Millijoules/ $\text{cm}^2$ )**

## UV Dose

- Design Requirement for UV are stated in terms of “Dose”
- UV Dose = UV Intensity ( $\text{mW}/\text{cm}^2$ ) x Exposure Time (seconds)

# Dose Response Curve Determination

- Place a sample in a petri dish
  - Know the concentration of the challenge organism
- Exposing the sample to collimated UV light for a predetermined amount of time
  - Measure the intensity of the UV light so you can calculate UV Dose
  - $UV\ Dose = 0.5mW/cm^2 * 30sec = 15(mW*sec)/cm^2 = 15mJ/cm^2$
- Measuring the concentration of the challenge organism before and after exposure
  - The different in concentration is used to determine the log inactivation, or percentage reduction, of organisms from a certain UV Dose
    - 1 log reduction = 90%
    - 2 log reduction = 99%
    - 3 log reduction = 99.9%
- Plot data a Dose Response Curve (green line)
- Use curve for future reference
  - Can be used to size a larger UV system (red lines)
  - Prevents the same testing being duplicated

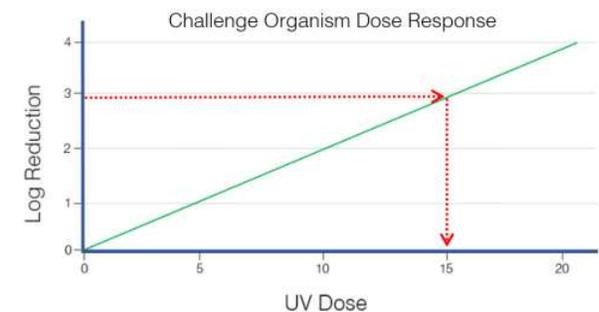


# What are Dose Response Curves Used for?

Average UV Dose Required for Inactivation (mJ/cm<sup>2</sup>)

Pathogen	1-Log	2-Log	3-Log	4-Log
<i>Cryptosporidium parvum</i> oocysts	1.3	2.5	4.3	5.7
<i>Giardia lamblia</i> cysts	0.3	0.7	1.3	1.7
<i>Vibrio cholerae</i>	0.8	1.4	2.2	2.9
<i>Shigella dysenteriae</i>	0.5	1.2	2	3
<i>Escherichia coli</i> O 157:H7	1.5	2.8	4.1	5.6
<i>Salmonella typhi</i>	1.8 - 2.7	4.1 - 4.8	5.5 - 6.4	7.1 - 8.2
<i>Shigella sonnei</i>	3.2	4.9	6.5	8.2
<i>Salmonella enteritidis</i>	5	7	9	10
<i>Hepatitis A virus</i>	4.1 - 5.5	8.2 - 13.7	12.3 - 22	16.4 - 29.6
<i>Poliovirus Type 1</i>	4.1 - 6	8.7 - 14	14.2 - 23	21.5 - 30
<i>Coxsackie B5 virus</i>	6.9	13.7	20.6	30
<i>Rotavirus SA 11</i>	7.1 - 9.1	14.8 - 19	23 - 25	36

Dose response curves are a critical input when determining UV system sizing for various water treatment applications



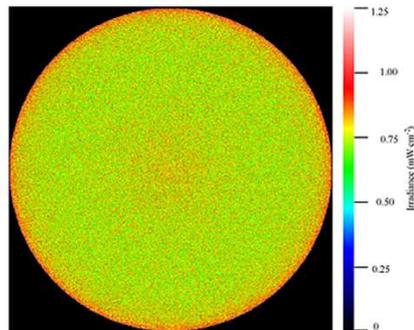
**Source:** Haji Malayeri, A.; Mohseni, M.; Cairns, B.; and Bolton, J. R. 2016 Fluence (UV Dose) Required to Achieve Incremental Log Inactivation of Bacteria, Protozoa, Viruses and Algae, IUVA News, 18(3): 4-6 + supp. tables.

UV Dose is Important Because Each Organism Will Respond Differently to UV. UV Systems are Typically Sized Based on the Organism that is Most Resistant to UV (e.g. Viruses)

# Petri Factor – Why it Matters

- The Petri Factor is the measure of intensity across a sample
  - The higher the number, the less variation there is across the area
- The PearlBeam has a Petri Factor greater than 0.9
  - Means the highest possible fluctuation in treatment across the surface is 10%
  - 0.9 is the research standard, and the PBM surpasses it
- Homemade Collimated Beams typically have very low Petri Factors
  - Hot spotting during testing
- PearlBeam can uniformly irradiate petri dishes up to 60mm in size

## Intensity Distribution



Typical 285nm Irradiance at the end of the collimating tube

PearlBeam

Model Number*	Wavelength (nm)	Irradiance** (mW/cm <sup>2</sup> )
S255	255	0.05
S285	285	0.7
D255/285	255 & 285	0.05 & 0.7
T255/265/285	255, 265, & 285	0.05, 0.3, & 0.7
T265/285/300	265, 285, & 300	0.3, 0.7, & 0.7
T285/300/365	285, 300, & 365	0.7, 0.7, & 13

\*Custom PearlBeams are available. Please contact us for details

\*\*Irradiance is measured at the bottom of the collimating tube.



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