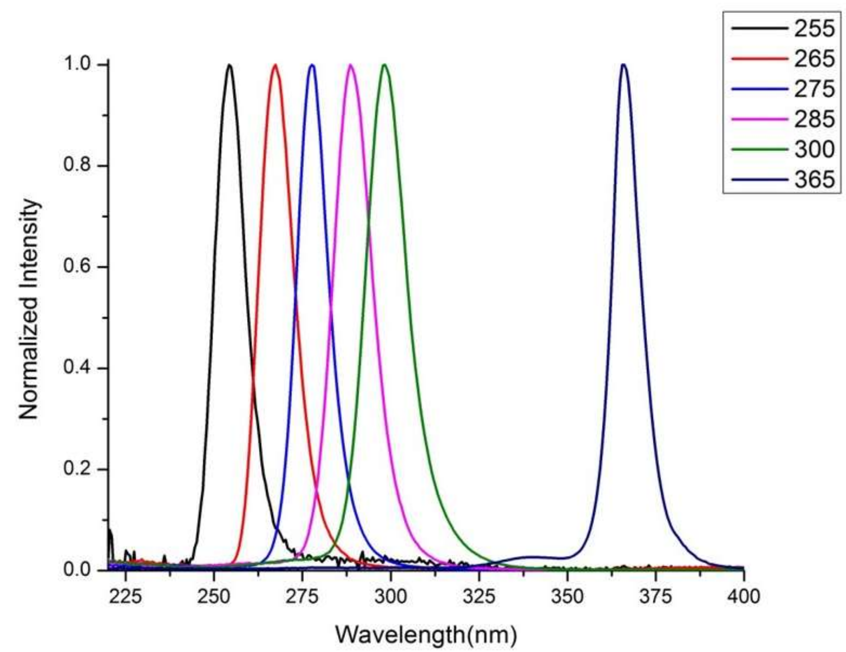
Collimated Beams – What are they used for?

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



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Collimated Beams and UV Dose

UV DOSE = INTENSITY X 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:

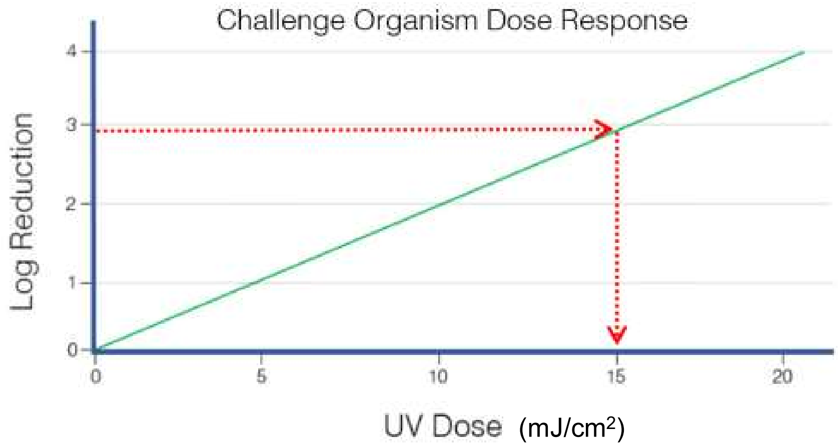
- μWsec/cm^2 (Microwatt seconds/cm^2)
- mWsec/cm^2 (Milliwatt seconds/cm^2)
- **mJ/cm^2 (Millijoules/cm^2)**

UV Dose

- Design Requirement for UV are stated in terms of "Dose"
- UV Dose = UV Intensity (mW/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



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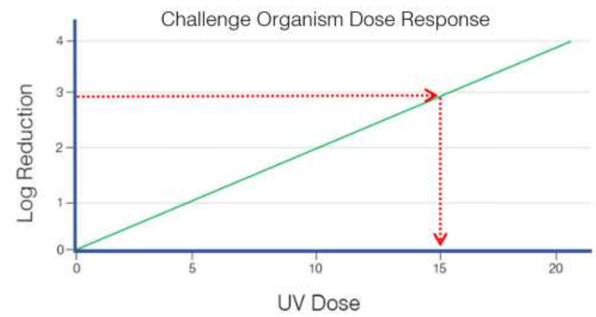
What are Dose Response Curves Used for?

Average UV Dose Required for Inactivation (mJ/cm^2)

Pathogen	1-Log	2-Log	3-Log	4-Log
Cryptosporidium parvum oocysts	1.3	2.5	4.3	5.7
Giardia lamblia cysts	0.3	0.7	1.3	1.7
Vibrio cholerae	0.8	1.4	2.2	2.9
Shigella dysenteriae	0.5	1.2	2	3
Escherichia coli 0 157:H7	1.5	2.8	4.1	5.6
Salmonella typhi	1.8 - 2.7	4.1 - 4.8	5.5 - 6.4	7.1 - 8.2
Shigella sonnei	3.2	4.9	6.5	8.2
Salmonella enteritidis	5	7	9	10
Hepatitis A virus	4.1 - 5.5	8.2 - 13.7	12.3 - 22	16.4 - 29.6
Poliovirus Type 1	4.1 - 6	8.7 - 14	14.2 - 23	21.5 - 30
Coxsackie B5 virus	6.9	13.7	20.6	30
Rotavirus SA 11	7.1 - 9.1	14.8 - 19	23 - 25	36

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.

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



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)

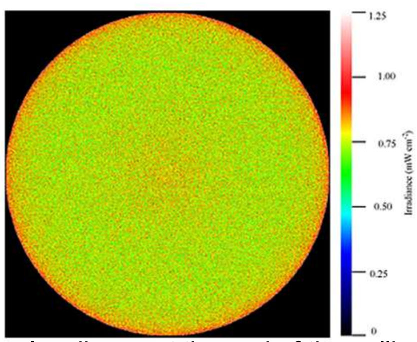
Petri Factor – Why it Matters

- 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

Model Number*	Wavelength (nm)	Irradiance** (mW/cm^2)
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.

Intensity Distribution



Typical 285nm Irradiance at the end of the collimating tube

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