Ultraviolet (UV) Treatment for Safe Drinking Water

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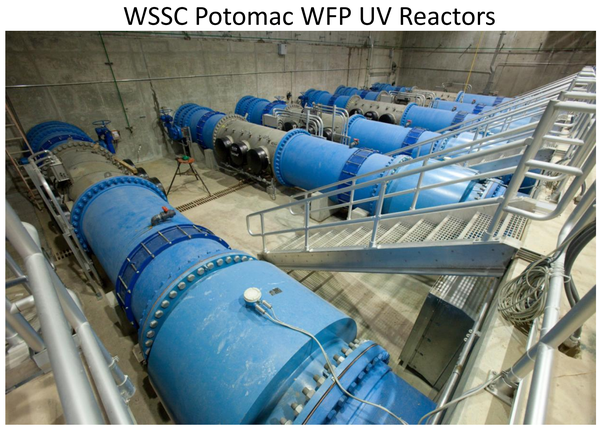
Background

- Ultraviolet radiation (UV) effectively inactivates common pathogens found in ground and surface waters such as *Cryptosporidium*, *Giardia*, and most bacterial pathogens (e.g., *E. coli*).
- Water treatment facilities recently started using ultraviolet radiation for disinfection of drinking water, supplementing standard chemical treatment.

WSSC uses UV for Drinking Water Disinfection

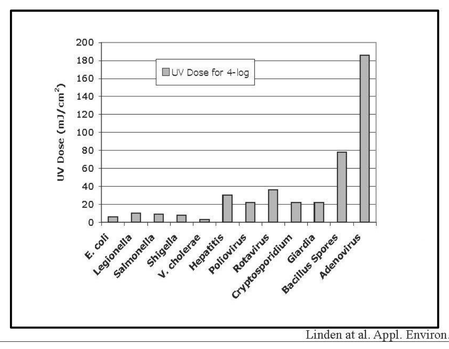
From ACE2011 UV Disinfection for the Real World: Back to Basics :WSSC Potomac Water Filtration Plant, Brian Balchunas,– Atkins and Joe Johnson - WSSC

WSSC Potomac WFP UV Reactors



From ACE2011 UV Disinfection for the Real World: Back to Basics :WSSC Potomac Water Filtration Plant, Brian Balchunas,– Atkins and Joe Johnson - WSSC

UV Inactivation of All Pathogens

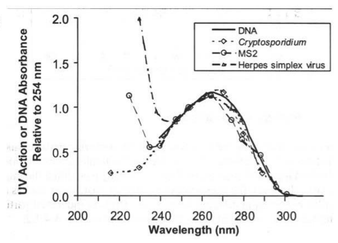


Linden at al. Appl. Environ. Microbiol. 2007

Note: "Log inactivation" is the percent of microorganisms inactivated (killed or unable to replicate) through the disinfection process. A 4-log inactivation value means that 99.99% of microorganisms of interest have been inactivated.

Action Spectra Differences

- **The germicidal effectiveness of UV varies with wavelength**
- **Important for MP UV (polychromatic)**
- **Different microbes have different wavelength sensitivities (action spectra)**



US EPA, 2006

Low Pressure (LP) Mercury UV lamps emit light at 254 nm. Medium Pressure (MP) Mercury UV lamps are polychromatic and emit light at several UV and visible wavelengths.

NIST Measurement of the UV Sensors

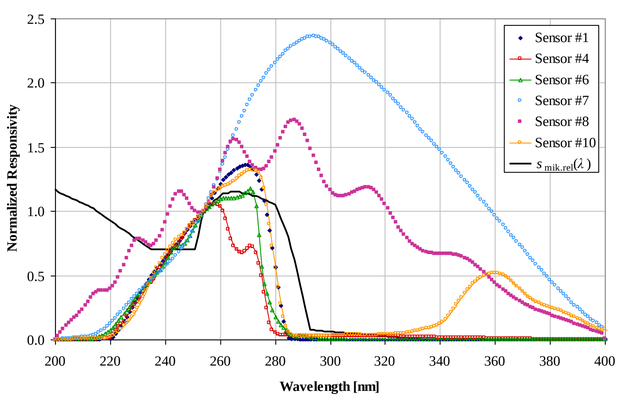
NIST tested several UV sensors (reference and duty) used to monitor UV reaction chambers in water treatment facilities for several characteristics:

- Absolute irradiance calibration at 254 nm
- Relative spectral responsivity, 200 nm to 400 nm
- Linearity of response
- Temperature dependence
- Angular responsivity

Some problems have been identified on the absolute calibration of these UV sensors.

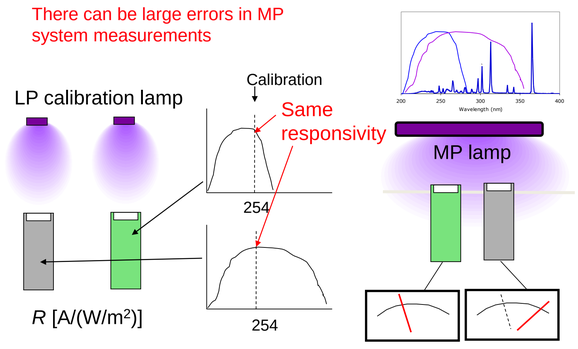
The results were published in "Design and Performance Guidelines for UV Sensor Systems" available from the Water Research Foundation.

Relative Spectral Responsivities of the UV Sensors

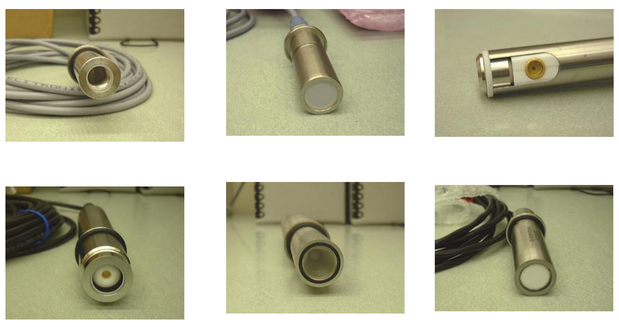


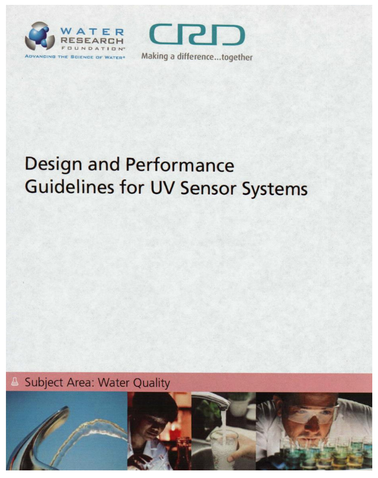
Spectral Responsivity – Problem

There can be large errors in MP system measurements



Example UV Sensors used in water disinfection





UV Inactivation of Water Pathogens

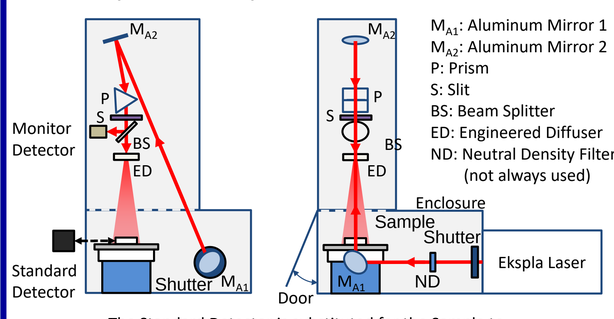
The goal of the project is to develop a guidance document for testing medium pressure (MP) ultraviolet (UV) light inactivation of adenovirus or suitable surrogates for groundwater systems to comply with the Ground Water Rule.

Study Microbes:

- Adenovirus – RG 2, also Type 40 and 41
- *Cryptosporidium* oocysts (Iowa strain) – RG 2
- *Giardia* – RG 2
- MS2 phage
- T1UV phage
- T7m phage
- Q beta phage

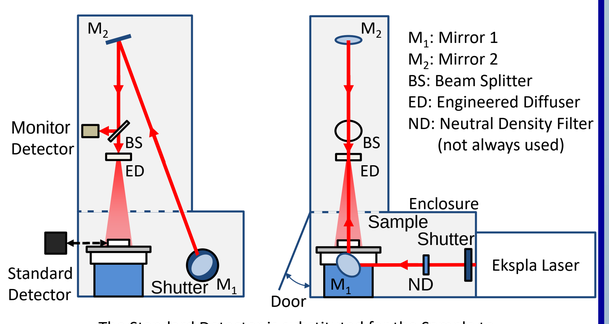
NIST UV Laser System

Optical setup for 210 nm to 230 nm



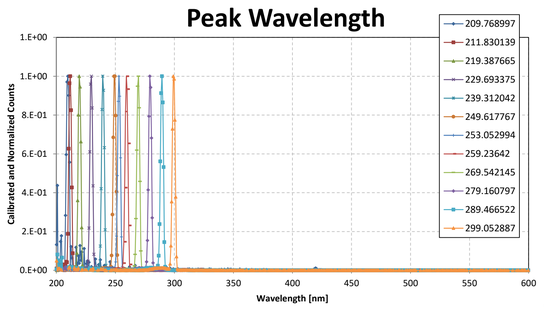
The Standard Detector is substituted for the Sample to calibrate the Monitor at each wavelength of interest.

Optical setup for 240 nm to 290 nm

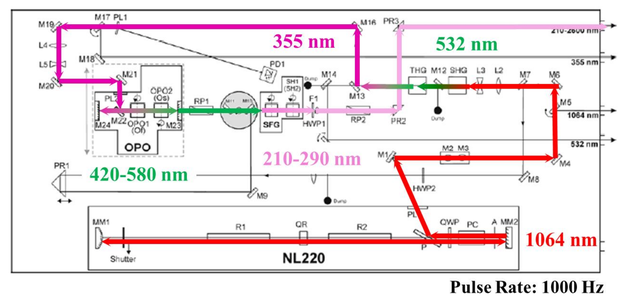


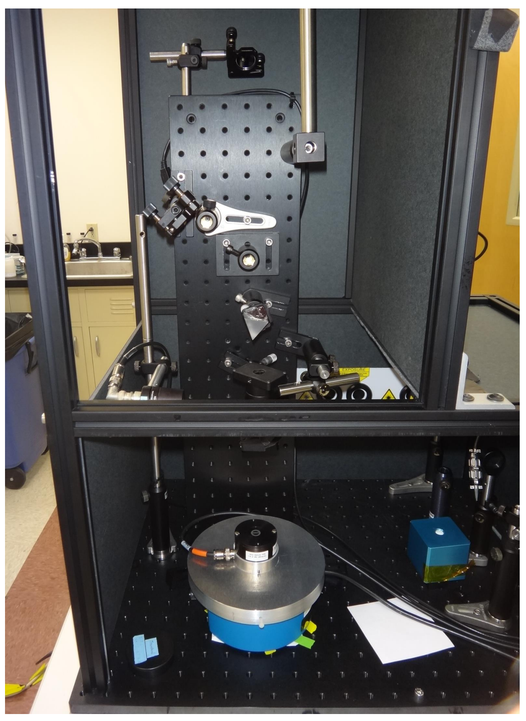
The Standard Detector is substituted for the Sample to calibrate the Monitor at each wavelength of interest.

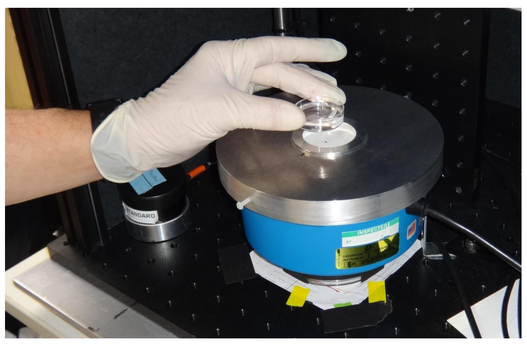
Calibrated and Normalized Counts to Peak Wavelength



Ekspla NT242-SH Tunable Laser







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- Harold Wright (Carollo Engineers)
- Christopher Schulz (Camp Dresser and McKee)
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- Sara Beck (Univ. of Colorado)
- Tom Hargy (TetraTech/CECV)

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