

## **Point-of-use Water Disinfection by Means of UVC LED's**

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# Clean water supply remains a challenge for humankind

**More than 20% of the world population does not have access to clean and safe drinking water\***



**Approximately 4000 people die every day due to biologically contaminated (germ infested) water\***



\*Source: World Health Organization (WHO)

## 1 PURION – your partner within UV-technology

2 UV-disinfection by means of traditional UV-lamps

3 UV-disinfection by means of UVC-LED

# The company PURION® GmbH develops and manufactures UV systems for the disinfection of water, air and surfaces



## Summary: Company data



## General Data

- Beginning of the business activity: 2006
- Certified according DIN EN ISO 9001 : 2008
- All systems are developed and produced at the location of the company PURION® in Thuringia.
- Projects in Germany, Austria, Spain, Thailand, Brazil, Haiti, Switzerland, Portugal, Denmark,...

## Products

- Disinfection plants for water, air und surface disinfection based on UV-technology
- Specialized on small plants for decentralized use (e.g. UV-systems with a power 300-1000 l/h)
- Actually as radiation source low pressure mercury lamps are used mainly

## Research

- Research on future UV-technologies (in cooperation with German universities)
- Member of the “Advanced UV for life” group: joint development of UVC-LED “point of use” systems within the program “twenty20 – Partnership for innovation” (funded by BMBF)

**Example: PURION products – for more information visit our website:**  
**[www.purion.de](http://www.purion.de)**

## Water



- Drinking water
- Pools
- Fish ponds
- Storm water of sewage plants
- Pharmacy
- Water of air conditioning
- Disinfection of permeate
- Aquariums

## Air



- Breweries
- Dairies
- Bakery
- Packaging industry
- Breeding farms

## Surface



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# Point of use disinfection of water is not only important for developing and transitional countries

*Examples: challenges and applications of “Point of Use” disinfection of water*

## Developing and transitional countries

- A central water supply doesn't exist in many countries and regions
  - The use of water sources near the surface of earth is growing (more germs infected than groundwater)
  - Sufficient trustfulness into public water supply is absent in many countries
  - ...
- Essential is the quality of water at the sampling point

## Developed countries

- Mobil applications e.g. ships, caravans and events of rescue and catastrophe
  - Within warm water installations for prevention against legionella
  - Well systems
  - Hygienical high sensitive sampling points e.g. health sector and food industry
- Essential is the quality of water at the sampling point

**What is necessary:**

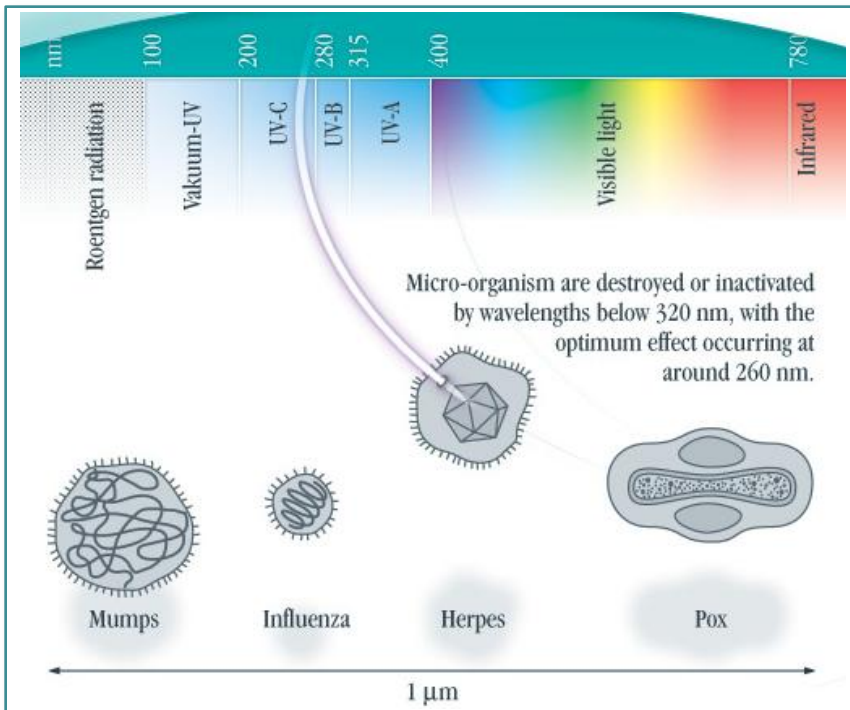
- I. appropriate methodology**
- II. technical solution**

# UV-C radiation is an effective method to disinfect water without toxic impact - Microorganism are destroyed or inactivated by wavelength below 280 nm (UVC)

## I. Operating principle of UV-C radiation

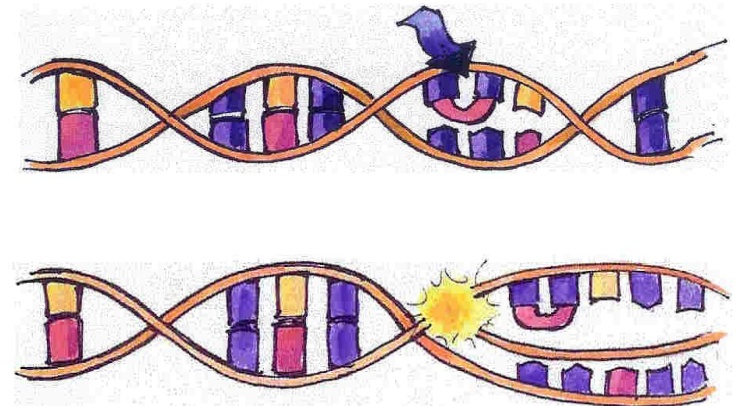
### Characterization of UV-C radiation

- Part of electro-magnetic radiation bounded by: the lower wavelength extreme of the visible spectrum and the upper end of the X-ray radiation band
- Spectral range: 100 - 400 nm (invisible to human eyes)  
→ UVC: ~180nm – 280nm (short wave radiation)



### Operating principle of UV-C radiation

- UVC works using a photolytic effect whereby the radiation destroys or inactivates the microorganism  
→ it can no longer multiply



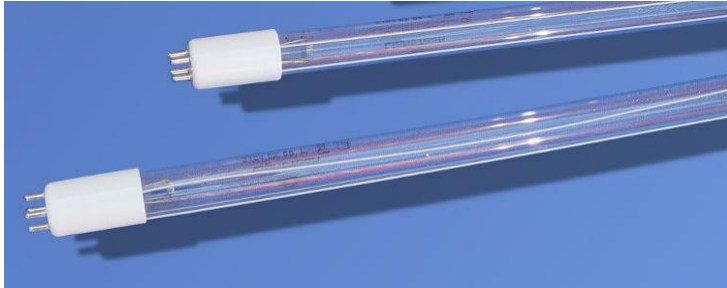


State of the art is the usage of low pressure mercury UV-lamps as the radiation source within a reactor (mostly stainless steel)

## II. Components and Installation principle of UV-plants

### Main Components of UV-plant

#### UV-lamp

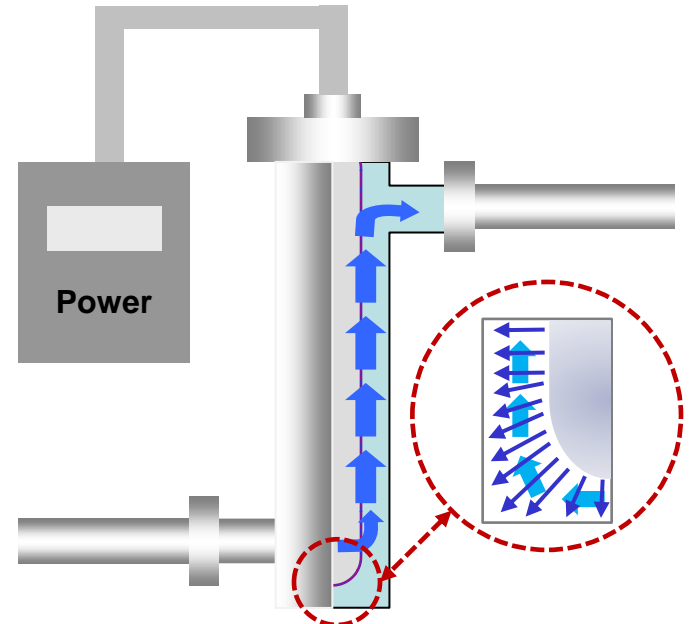


#### reactor



### Installation principle

- The distance between the UV lamp and the reactor has to be calculated taking account of the transmission of water
- Flow of water should be from the bottom up to the exit of the reactor

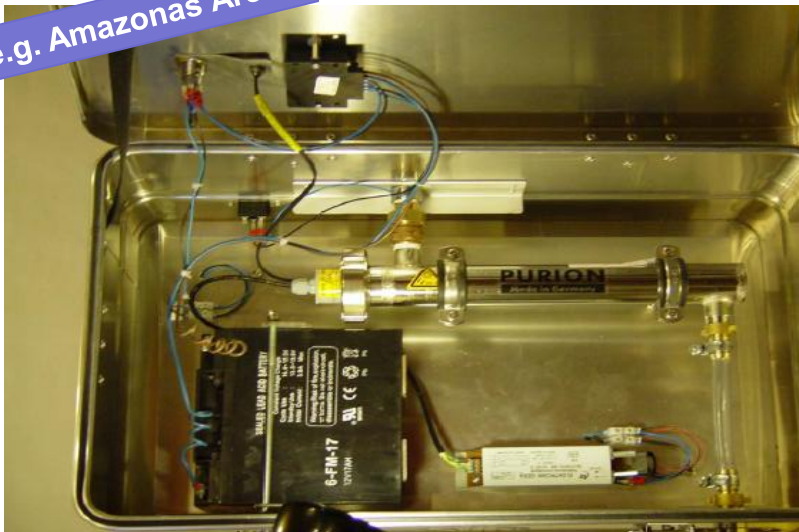


# Point of use disinfection of water today is realized by using small UV plants – natural boundaries given by the minimal length of the UV-lamp

## II. Example: Point of use applications today

### Developing countries: Tropics Box

e.g. Amazonas Area



- Realisation of a compact system to ensure uv-disinfection of surface water
- The system should be adequate according to tropical conditions and suitable for been run independent from power supply systems
- Suitable to for operation via solar power

### Developed countries

e.g. Expedition vehicle



- Possibility for decentralized disinfection of water for Caravans, expedition vehicles etc.
- System should be space-saving and shatter proofed

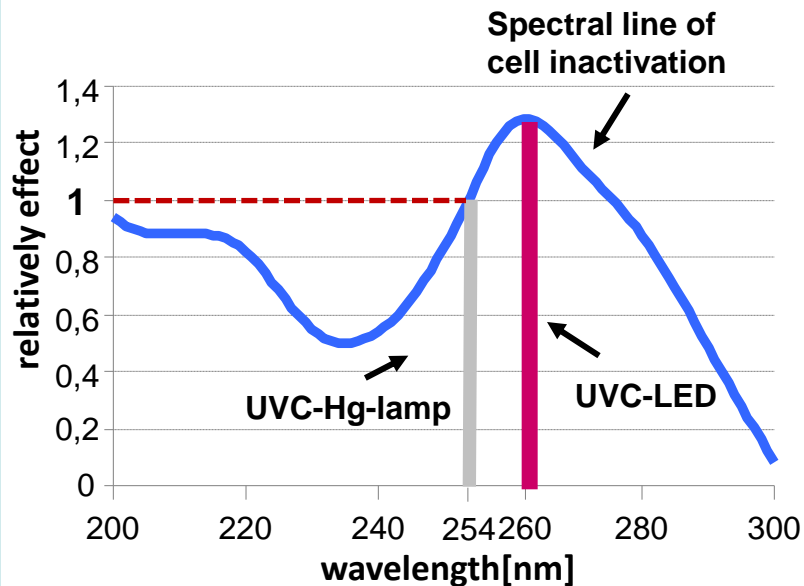
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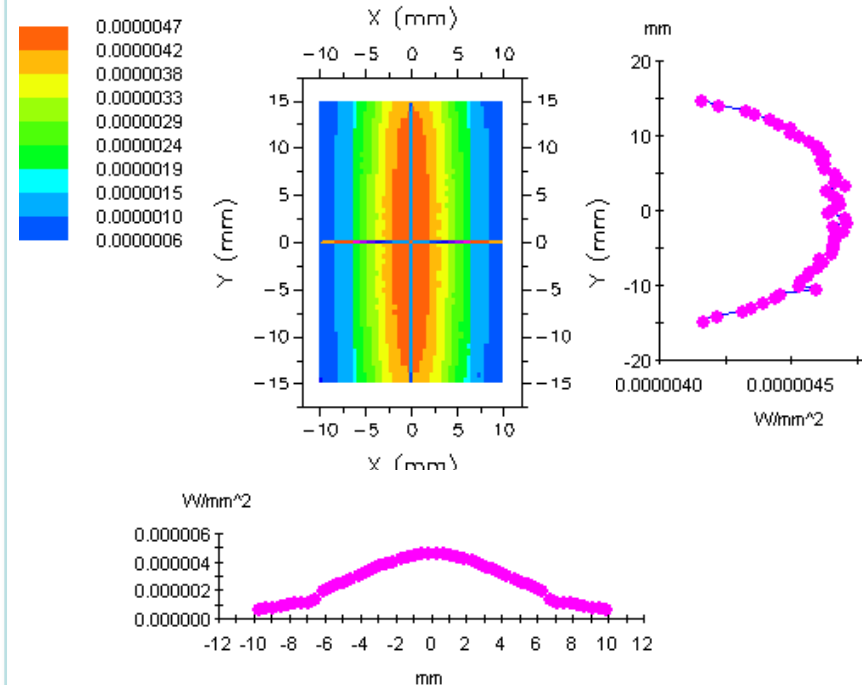
# UVC-radiation for disinfection of water can be emitted by LED – technical solutions to be developed

## I. Basics: disinfection by means of UVC LED's

### Disinfection effect of the UV radiation from LED's



### Structure of the intensity of UV radiation from LED's (surface emitting diode)



- The adapted wavelength of LED allows an increase of efficiency by approx. 20% to HG lamp



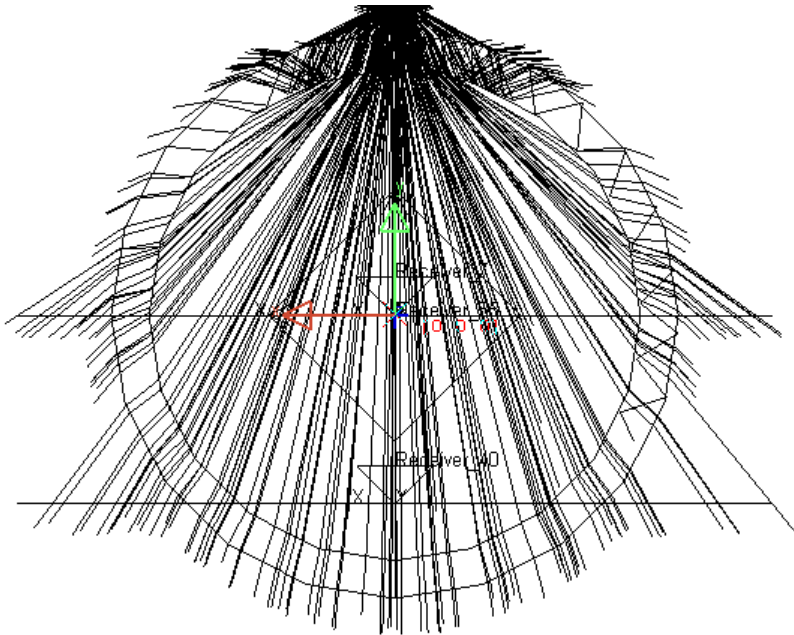
- Radiation intensity of a UV-LED is distributed elliptical
- Full intensity immediately after switch on



# The development of geometries for disinfection plants has to base on the diffusion pattern

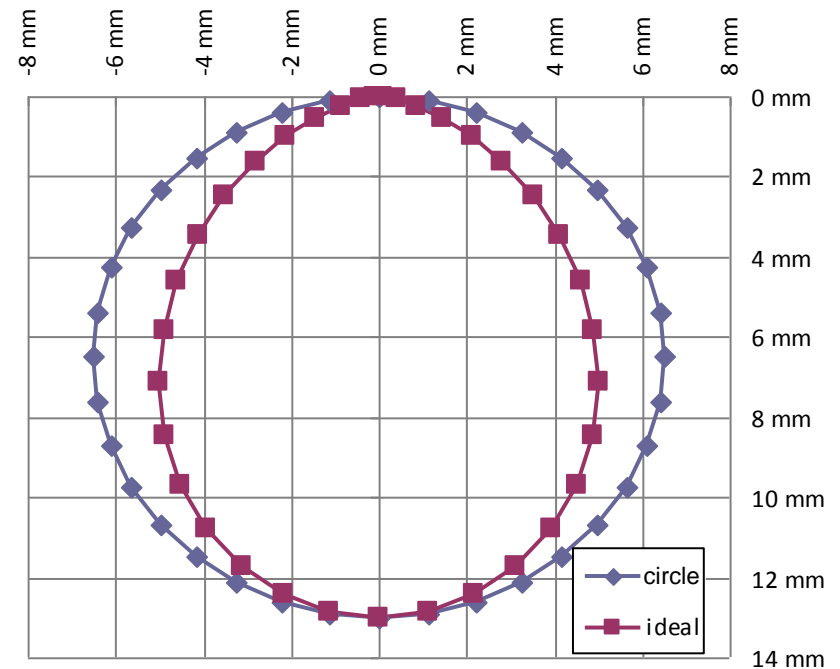
## I. Design of pipe geometries

### Simulation of the Structure of the UV radiation from LED's (surface-emitting diode)



- The diffusion of radiation starting from the surface of the chip has been simulated

### Development of pipe geometries



- The circle is not the optimal geometry for a homogenous radiation
- How to get elliptical geometries?

# PURION already did first research regarding possible geometries of a reactor for usage of LED

## II. *Examples for reactor geometries*

### First test results

with swirl



with double notches



with triple notches



#### *Aim:*

Development of reactor design under consideration of UV-LED radiation pattern, adjustment of water flow and circulation

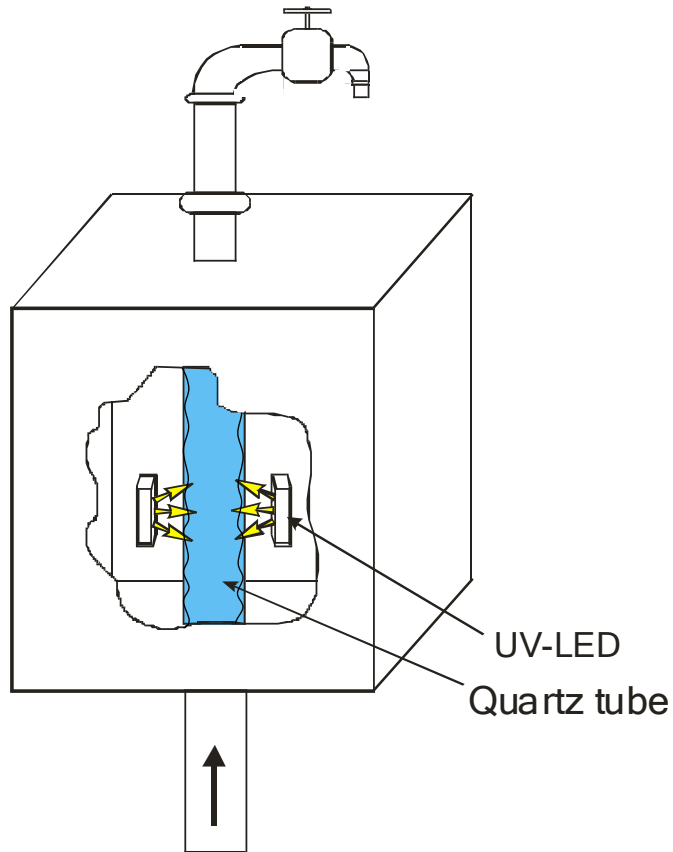
#### *Approach:*

Deformation of the quartz pipe to generate turbulences in the area of radiation

Due to the small size of UVC-LED's installation can be carried out very flexible and close to the sampling point

## II. Example

### Schematic example for installation



### Questions to be answered

Optimal geometry of the quartz pipe

Optimal arrangement of the UVC-LED's

Packing density of UVC-LED's

Optics for LED

# Further R&D regarding UVC-LED has to be carried out - the potential advantages of this technology are extensive

## *Summary of potential advantages of UVC-LED*

- Energy efficiency due to
  - Possibility to adjust the wavelengths of the UV-light according to the maximum of the DNA - absorbent band
  - Immediate readiness for operation after switch on
- Small power and voltage peaks during switch on
- Safe operation due to safety extra-low voltage
- Possibility to adjust the radiation characteristics
- Narrowband emission without disturbing side peaks (unwanted generation of OZON)
- Ecologically friendly due to absence of mercury
- No thermal radiation
- New geometries also for very small flow rates
- Robust and shatter proofed



**UVC-LEDs are a great opportunity to improve the existing UVC water disinfection technology**



**It will become possible to realize the disinfection of water directly at the sampling point.**



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