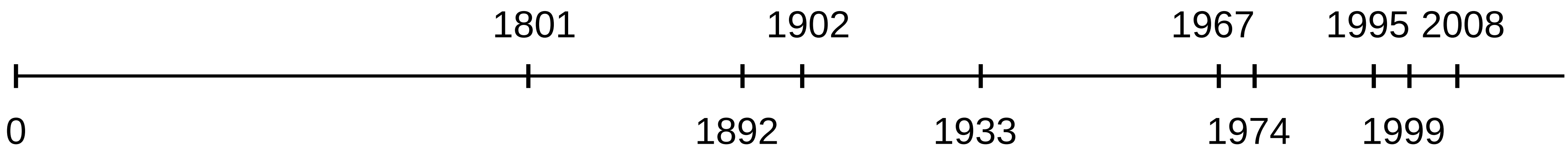
LED Overview

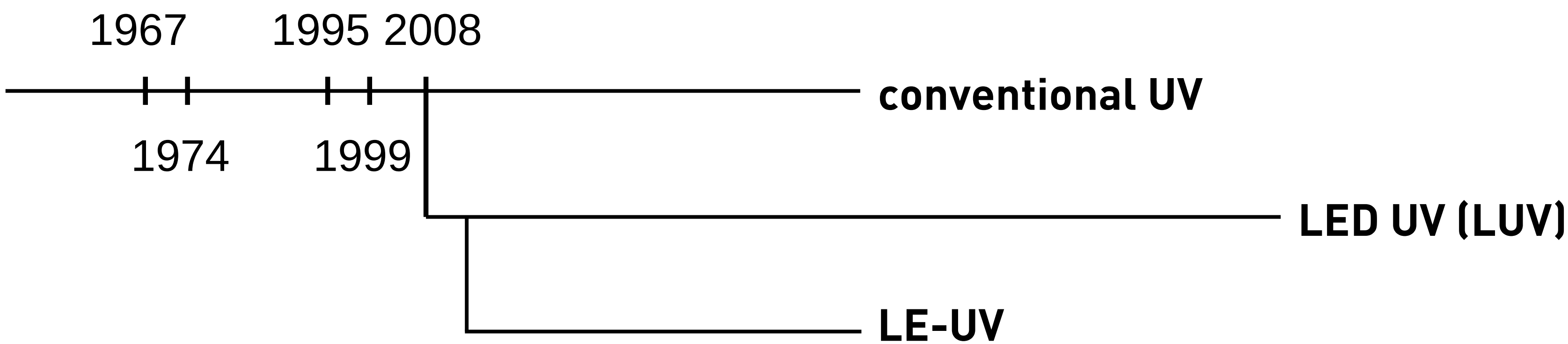
IST METZ GmbH, Stefan Feil

UV History



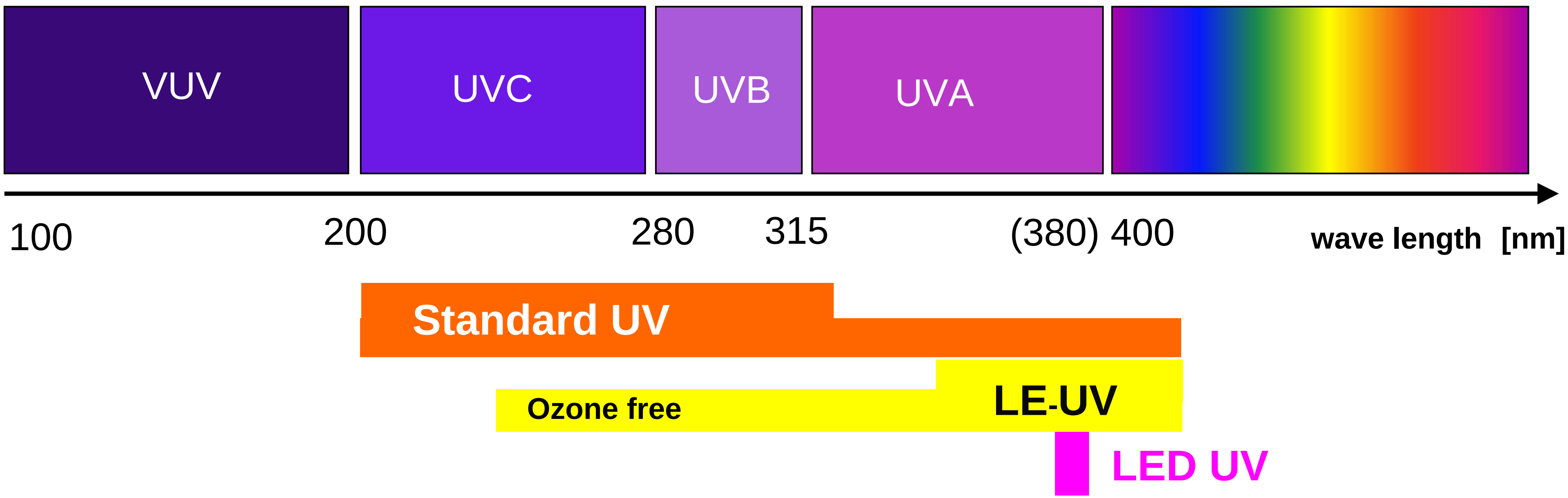
- **1801: Discovery of rays < 380 nm through physicist Johann Wilhelm Ritter**
- **1892: Invention of mercury pressure lamp through physicist Martin Leo Arons**
- **1933: Expanded production of mercury pressure lamps**
- **1967: Development of UV-inks and UV-coatings**
- **1974: First UV installations in printing industry**

Turning point 2008?



- Development LED ink
- High reaktivity in (complete) UVA range
- Enables power reduced systems

UV-light sources



Market trend

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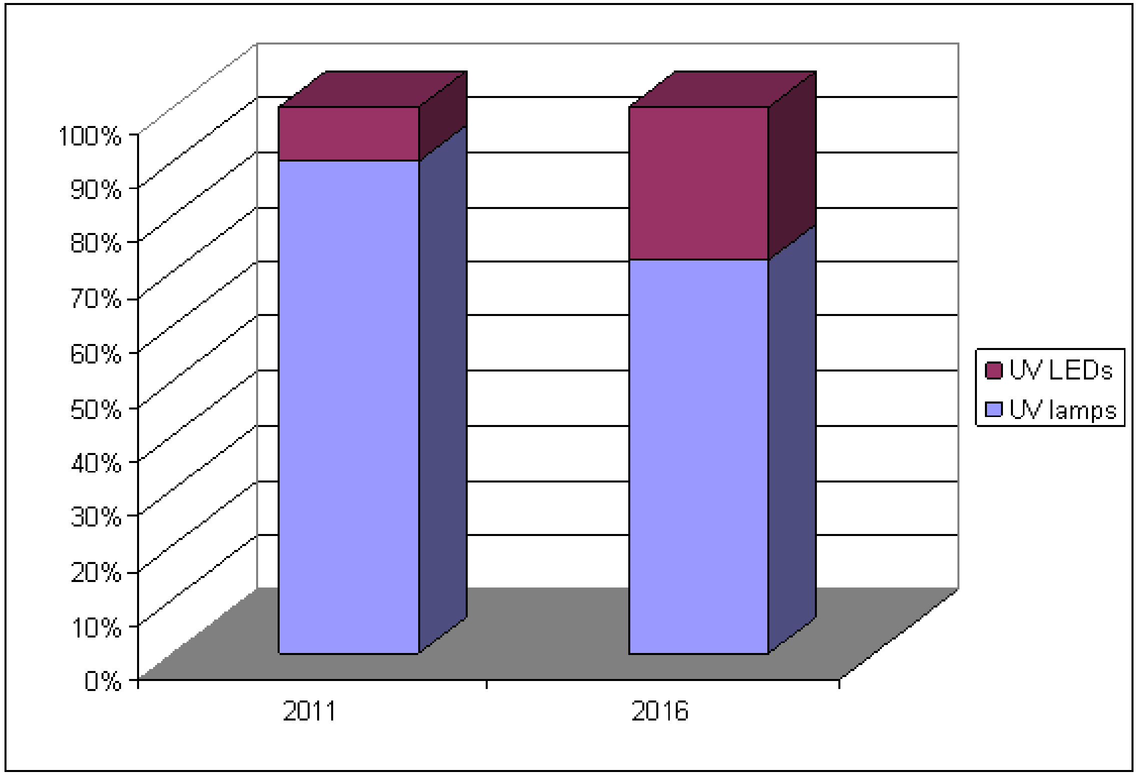
Market share

UV Market

- **Disinfektion**
- **Medicine**
- **Measuring devices**
- **Counterfeiting**
- **Curing**

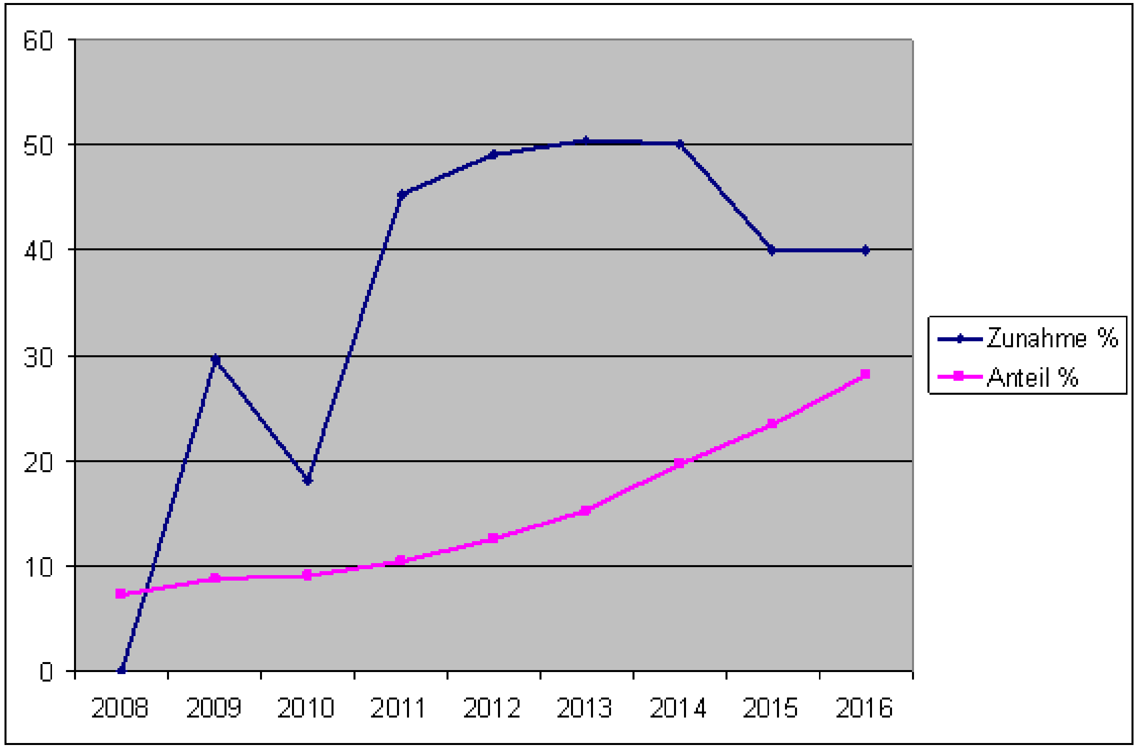


Source: Zahlenbasis Yole

Market development

UV Curing

- **Printing**
- **Adhesives**
- **Industrial**
- **Inkjet**

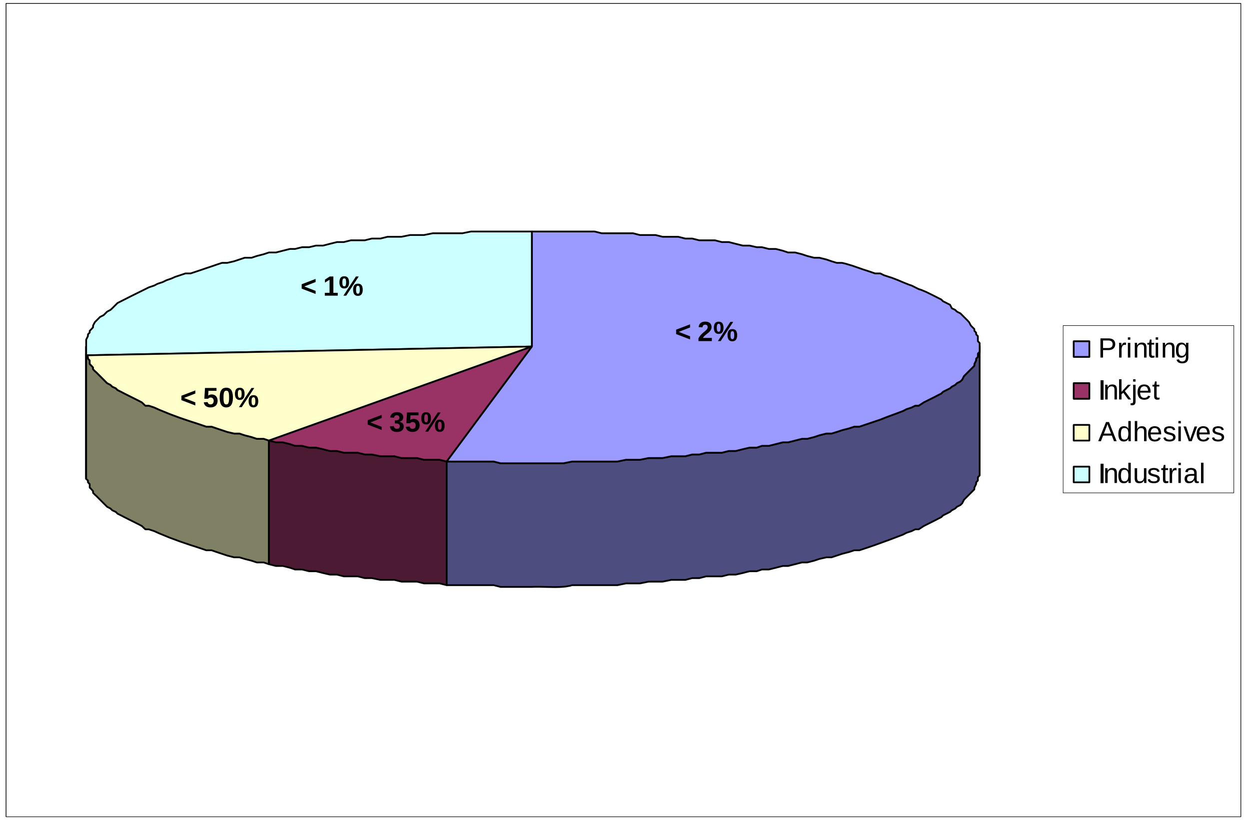


Source: Zahlenbasis Yole

Market- and LED distribution

UV Curing

- Printing 55 %
- Adhesives12 %
- Industrial 26 %
- Inkjet 7 %

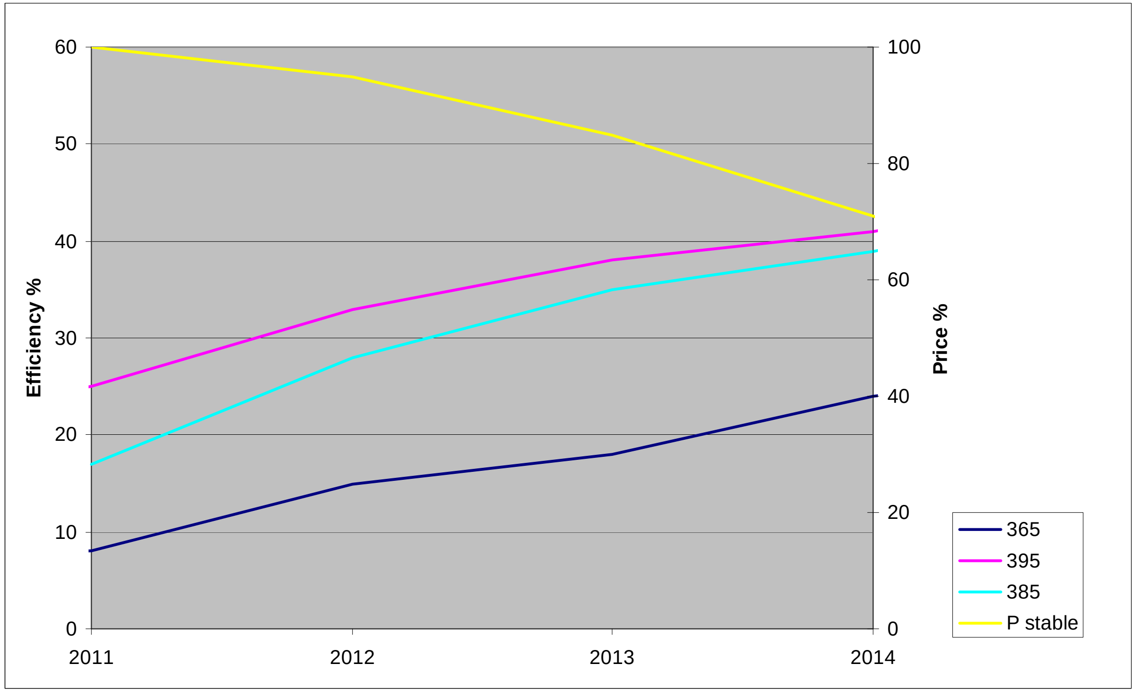


Source: Zahlenbasis Yole/IST

Efficiency- and price trend

Price decline, but

- **Limited competition (Number of chip producers)**
- **Quantities**
- **Quality**
- **Excess demand of power**

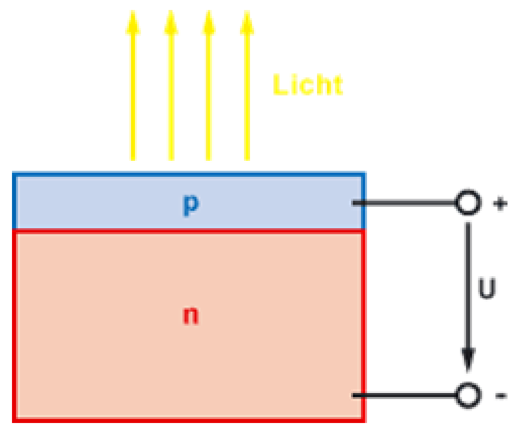


Quelle: Zahlenbasis Yole/IST

LED Technology

LED function

- Semiconductor crystal on substrate
- n-conductor with mobile electrons
- p-conductor with mobile electron holes
- Forward voltage creates migration of electrons
- Recombination of electrons and holes
- Emission of light (nearly monochromatic light)



Chip efficiency (EQE)

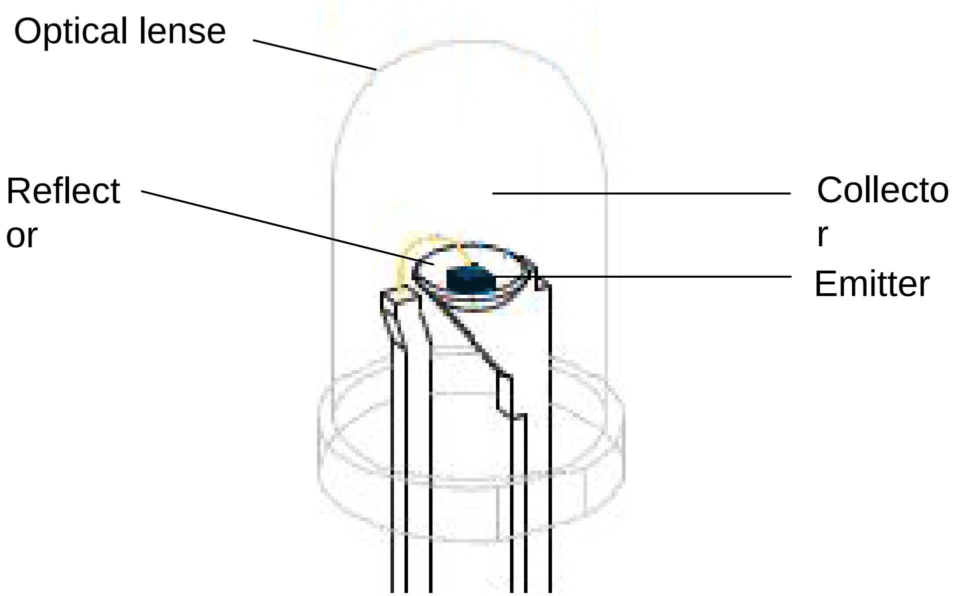
- Efficiency is measured by extrenal quantun efficiency (EQE)
- Describes the LED capability to convert electrones into photons
- Relationship between optical output to electrical input
  - at working temperature of 25°C
  - at (low) nominal current

Efficiency of LED

EQE is not the scale of real efficiency. Additional reductions in efficiency occur through:

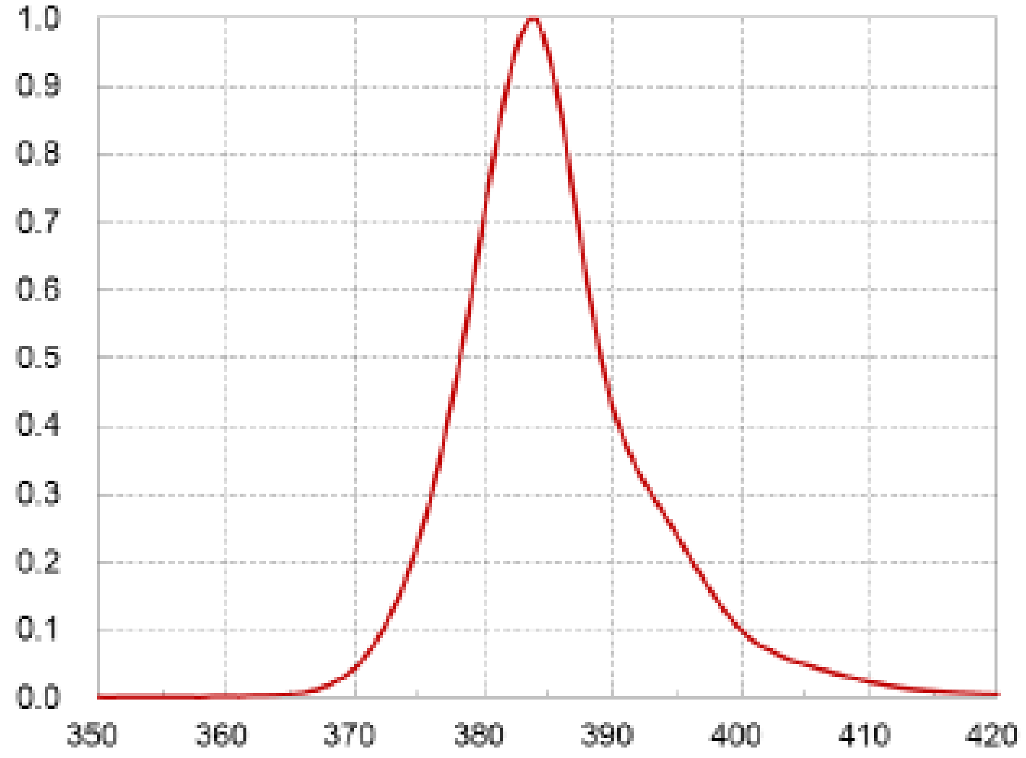
- **Demand of power**
  - **Greater current**
  - **Higher working temperature**

- **Optics**
  - **Light collector**
  - **Light forming**

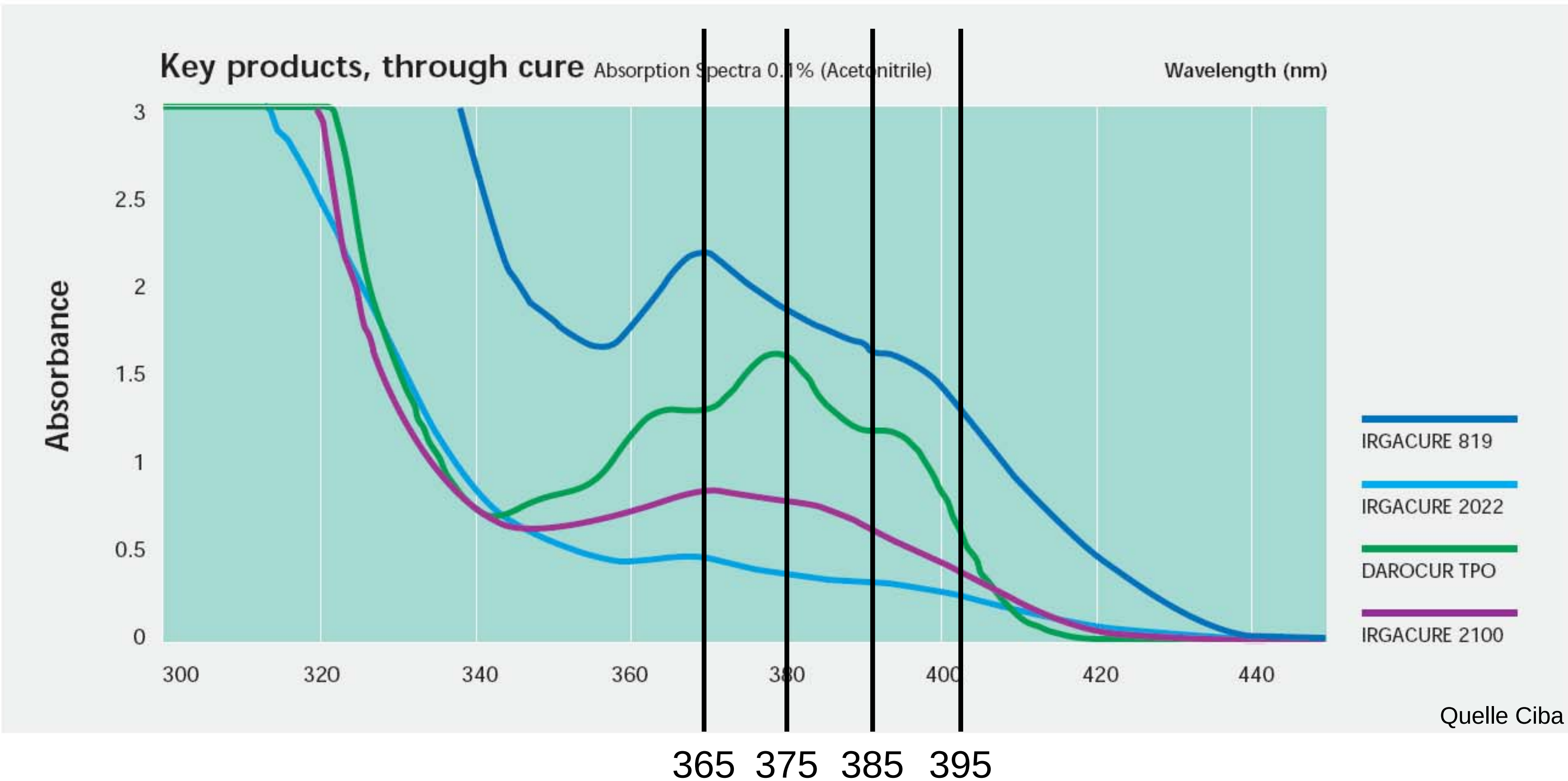


Half width

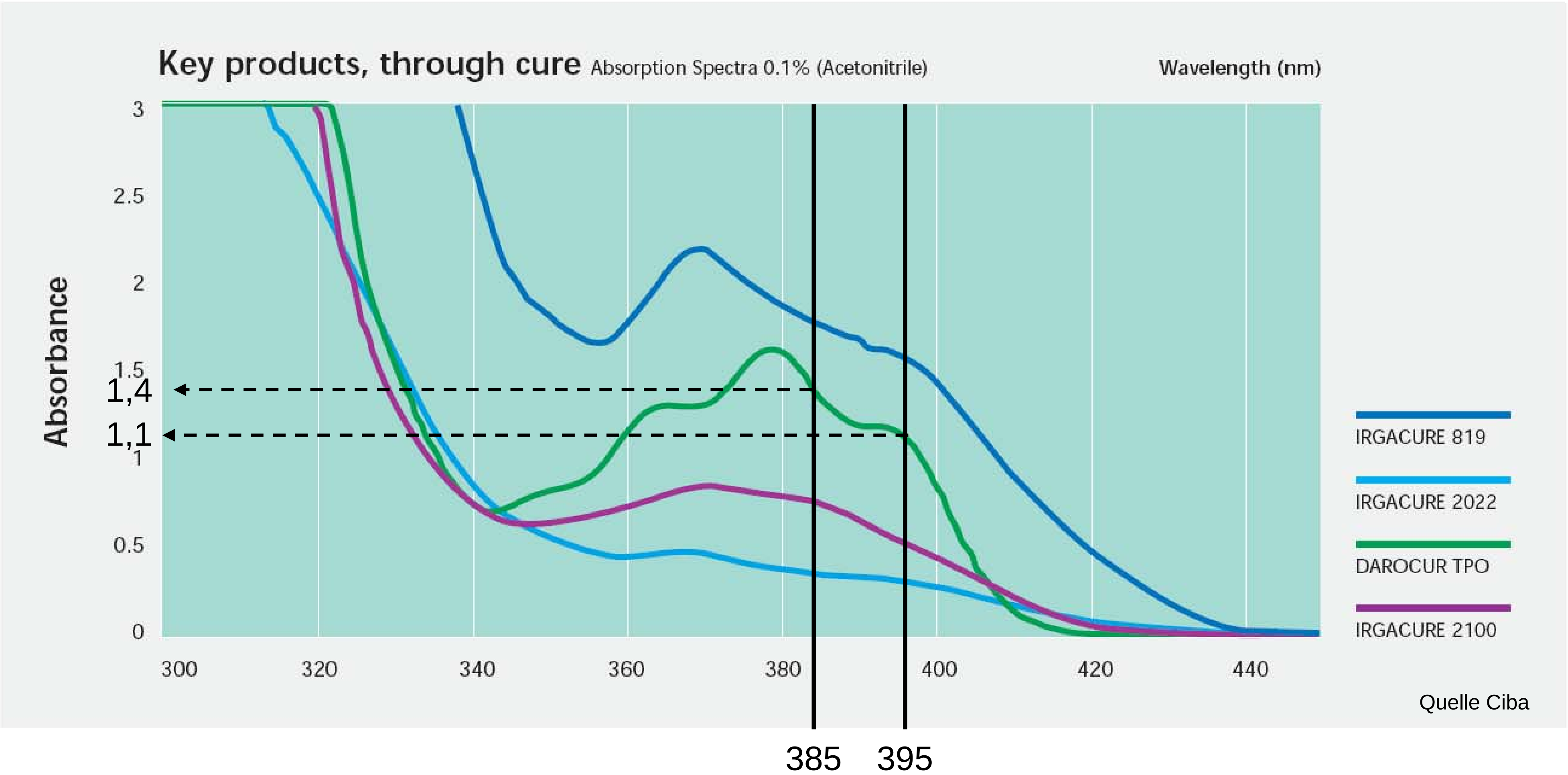
- **Describes the spectrum width at 50% of maximum emission**
- **Nominal wave length 385 nm**
- **Half width of 12 nm (378 – 390 nm)**
- **Total width at low emission levels in the range 373 – 398 nm**



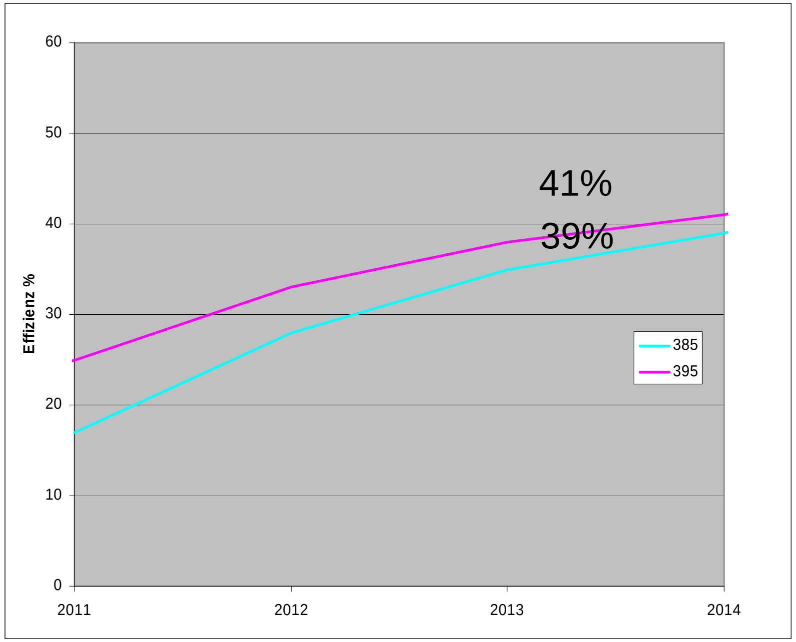
Selection of wave length



Maximum Sensitivity



Response



RESPONSE:

Determined by absorption of PI and efficiency of LED system

CALCULATION:

- **385 nm:**
  1,4 x 0,39 = 0,546
- **395 nm:**
  1,1 x 0,41 = 0,451

SUMMARY:

Better response is achieved at 385 nm

Power rating

What is the right figure, resp. suits better?

- **UV lamps:**
  W/cm = electrical input
  Electrical power consumption per cm lamp length
- **UV LED:**
  W/cm² = optical output
  Light intensity per cm² surface area

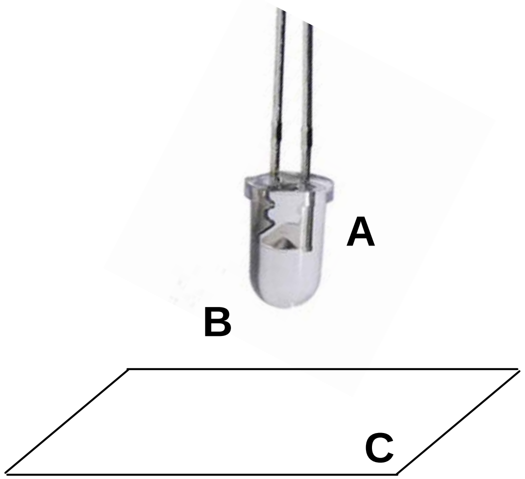
Quo vadis W/cm² ?

MEASURING DEVICE

- No standards
- Calibration in reference to Hg-lamp
- Insufficient spectral sensitivity

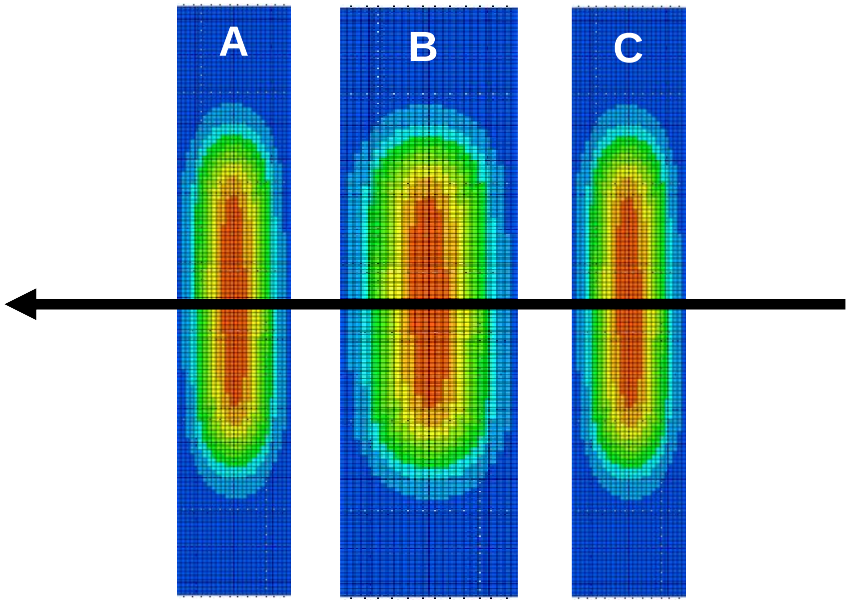
MEASURING POINT

- Chip surface
- Emission window
- Substrate level



MEASURING FIELD

- Areal distribution
- Temporal distribution



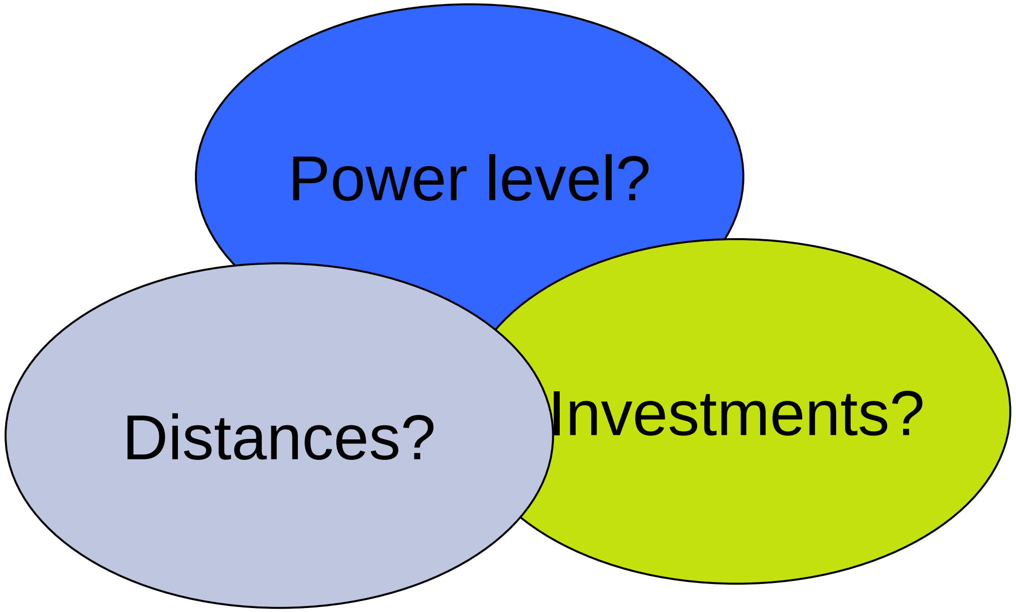
W/cm² = constant

LUV Development

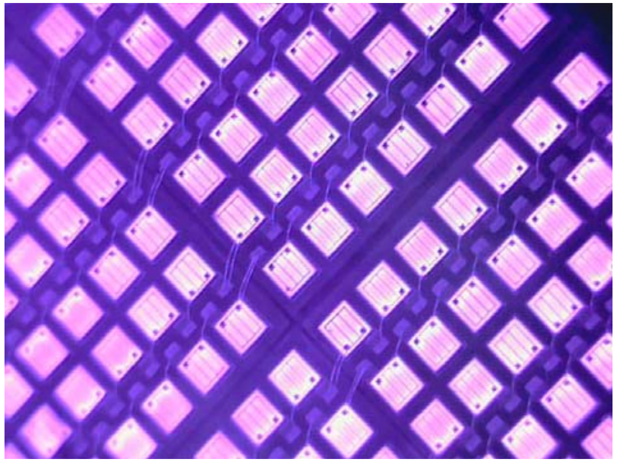
Optimisation LUV1 → LEDcure

Target for successor

- **Reduction of power loss depending on gaps to enable applications with wider working distances**
- **Different solutions for different applications resp. distances**
- **Lowering of investment costs**



Optimisation LUV1 → LEDcure

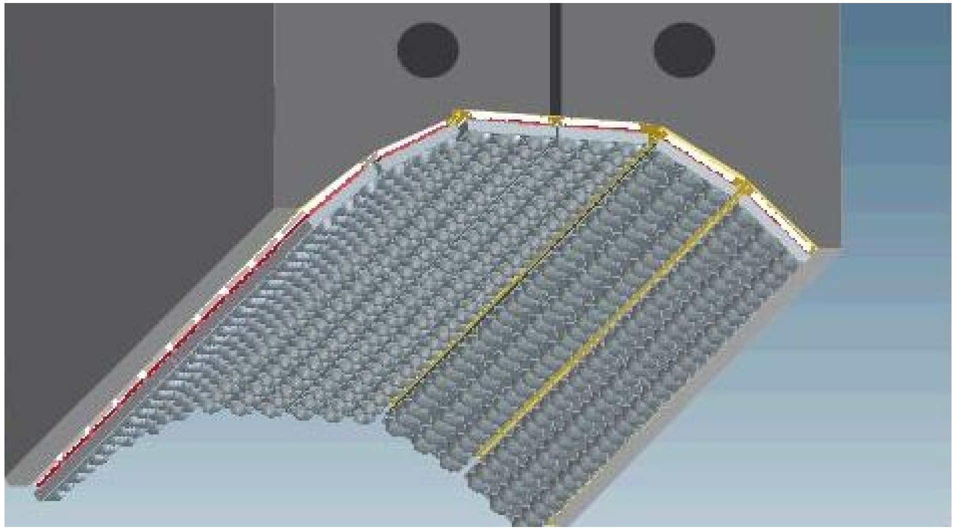


- Lowering of investment costs
  - less LEDs, but better output levels
- Efficient chilling of LEDs
  - high efficiency
  - long life time
  - low degradation
- Process improvement
  - High intensity levels with wider working distances
  - Good homogenity (max. +/-10%) in nominal distance
  - Format switching
- Modularity
  - All right scalability
  - Population with wave length from 365 – 405 nm

LEDcure

- Applications with medium working distances
- Lense array

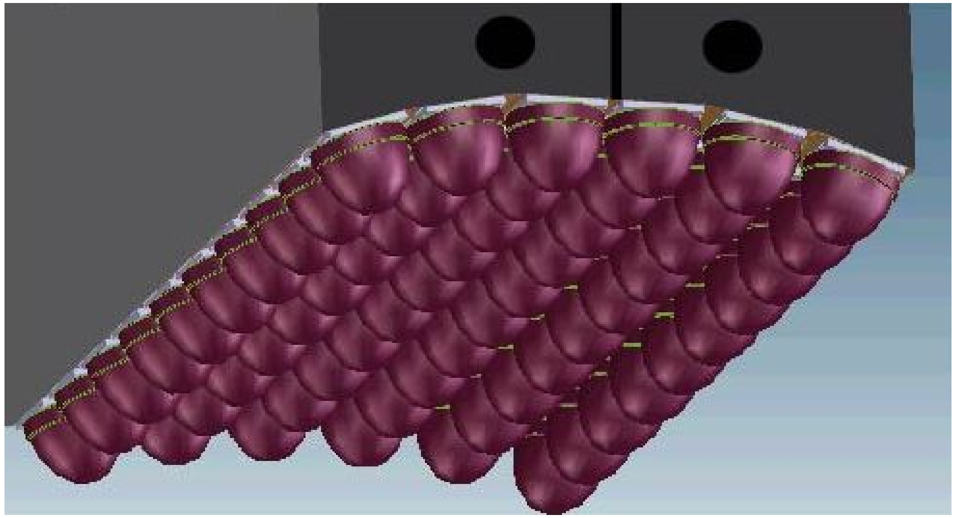
→ Setting angle and lense geometry optimised for nominal working distance 20 mm (resp. for field of work between 10...50 mm)



LEDcure

- Applications with wider working distances
- Single lenses

→ Setting angle and lense geometry optimised for nominal working distance 80 mm (resp. for field of work between 40...100 mm)



Frequently Asked Questions

Energy saving – How much?

How much energy I do will safe with LED?

- **Energy saving is possible due to higher reactive ink.**
- **A comparison between UV and LED on basis of the installed power is questionable, since the chemistry is exchanged as well.**
- **An effective comparison has to be done according to a defined curing result.**
- **Defining a desired curing result will allow the determination of needed power levels.**

Energy saving - Where?

Under which conditions will a LED save energy?

- **During Stand-by the system is off**
- **A format switching will turn off LEDs outside the printing**

An energy calculation is possible but has to consider:

- **Effective needed power for curing**
- **Duration of stand-by times, resp. production scenarios**
- **Average printing size**

UV-LED differences

- Investment costs
- Costs of ink
- Ink adhesion more delicate
- Inhibition surface stronger
- Ink formulation more difficult
- Low migration hardly existing
- Yellowing tendency coating
- Higher light sensitivity
- Active water cooling
- Exchange wear parts

- No mercry, no ozone
- Pure and cold UV light
- Smaller heat input
- Pulsable (on/off)
- Patented zone switches (option)
- Energy saving potential (only in stand-by and during switch-off of zones)
- Longer lifetime
- Compact design
- No exhaust air installation

Thank you

IST METZ GmbH