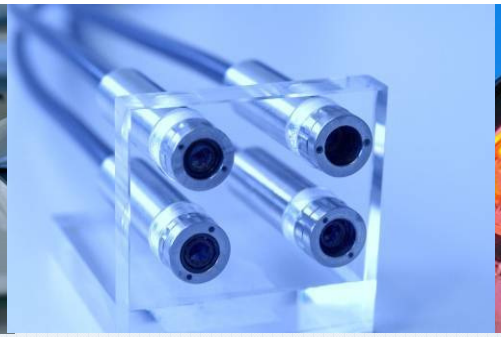
Light is vision.

Volpi AG

Faseroptik **Optik** **Opto-Elektronik** **Engineering**

Efficient Lighting
in
Medical Technology

Dipl.Phys. Reinhard Jenny / 03.11.2010

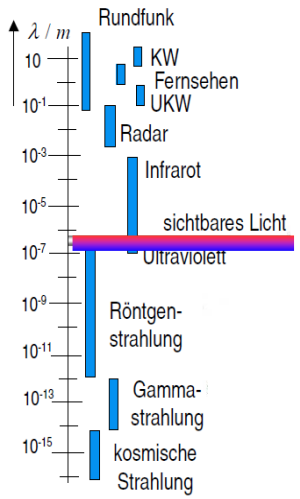
Lighting

Lighting ➔ in general associated with „illumination“

➔ light = related to visible part of EM-spectrum

elektromagnetische Strahlung und Licht

Aufteilung des optischen Strahlungsspektrums nach DIN 5031



Strahlungs-bezeichnung	Wellenlängen-bereich / nm
IR - C	3µm - 1000µm
IR - B	1400 - 3000
IR - A	750 - 1400
Licht - rot	640 - 750
Licht - gelb	558 - 640
Licht - grün	495 - 558
Licht - blau	440 - 495
Licht - violett	380 - 440
UV - A	315 - 380
UV - B	280 - 315
UV -C	100 - 280

Sunlight accompanied all biological processes and evolutions.

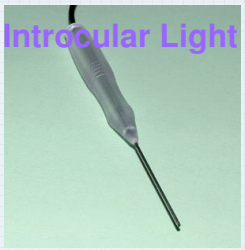
Sunlight ⇔ Life on earth as well our visual perception is highly adapted)

Sunlight ⇔ Standard for Color rendering CRI = 100%

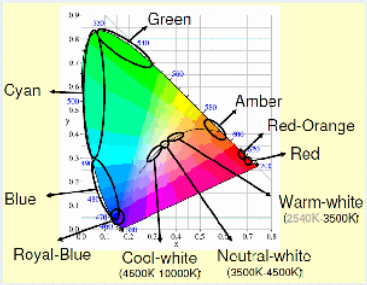
Lasers and Laser-Applications will be excluded in this presentation

Lighting ⇔ Illumination

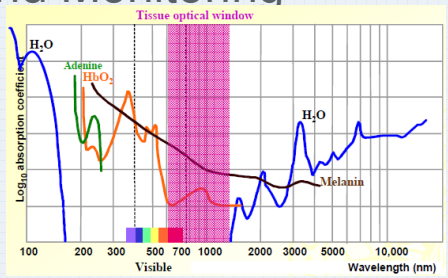
Visual examination and imaging techniques

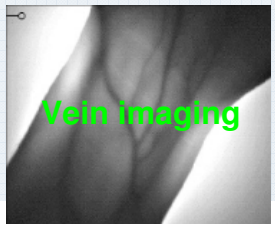


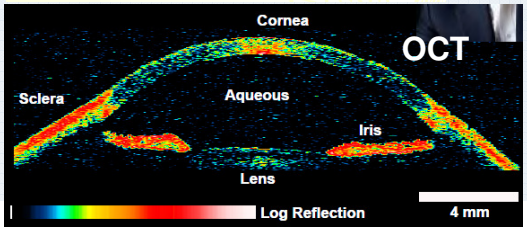
⇔



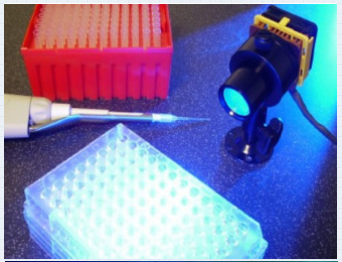
Diagnostics and Monitoring



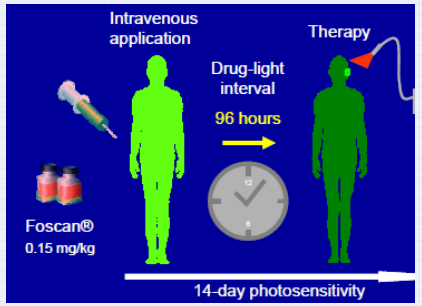




In Vitro



PDT / Phototherapy



Dental Light Curing

Efficiency in Lighting

Efficiency in

- Light Generation
  - ➔ *Light-Parameters : spectrum, intensity, coherence polarisation, modulation*
- Light Capturing (Coupling to Light Source)
- Light Transfer
- Light projection or Light shaping on the object

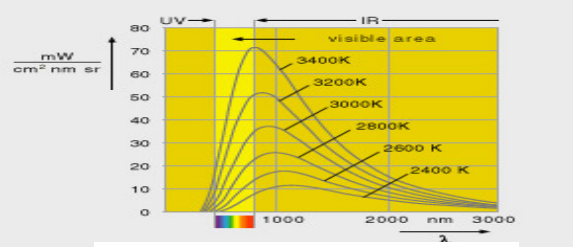
Efficiency in Light Generation

Efficiency in Light- Generation

Medical Technology ➔ *Halogen lamps, Xenon arc lamps, Metal Halide lamps*

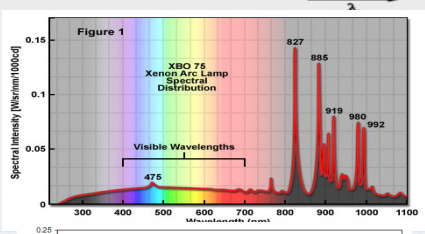
HALOGEN - Lamp

Planckian emitter; Color **CRI ~ 92 %**; **T ~ 3000K** ;
Life : 30 – 2000 hours; Efficiency : 20 – 30 Lm/Watt
rel. Simple power supply; rel. stable light



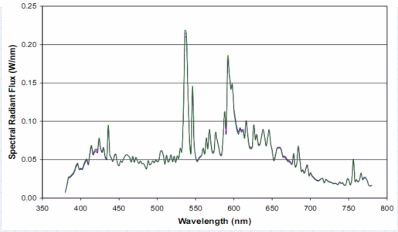
Xenon arc Lamp

Similar sun light; VIS spectrum smooth;high pressure gas;
T ~ 6000K; **CRI ~ 98 %**; Life : typ. 200 – 1000 hours;
High energy in NIR; Efficiency : 20 – 30 Lm/Watt;
complex power supply; random intensity fluctuations



Metal Halide arc Lamp

Line spectrum in VIS; **T~ 5500K**; **CRI ~ 80 %**;
Life : typ. 200 – 1000 hours; possible color faults
Efficiency : 80 – 90 Lm/Watt;
complex power supply; random intensity fluctuations

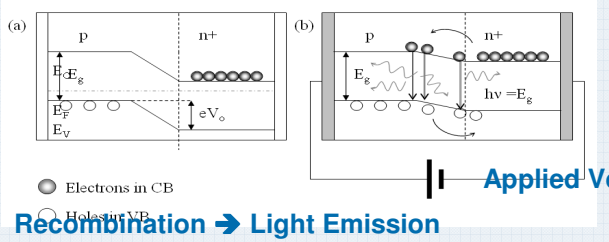


Efficiency in Light-Generation - LEDs

New high efficient Solid-State-lightsources are coming up

LED … Light Emitting Diodes

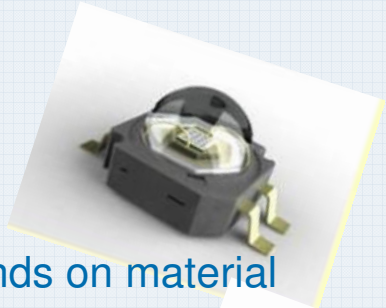
(1st red LED 1961from GE)



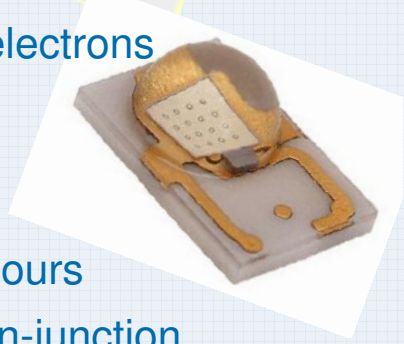
Recombination ➔ Light Emission

Energy-Gap E_g =hv defines emitted wavelength

LEDs are semiconductors



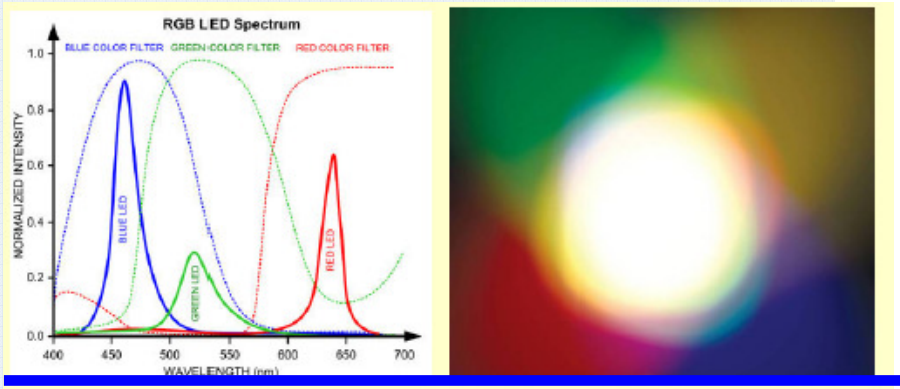
- Narrow band emission
- Emitted wavelength depends on material
- Intensity proportional to injected electrons (current)



- LEDs can be dimmed continously
- High Luminance / Radiance
- Life : L_{70} / L_{50} .. 30000 – 50000 hours
- Life depends on temperature of pn-junction
- LEDs have to be cooled
- Safety by low voltage operation

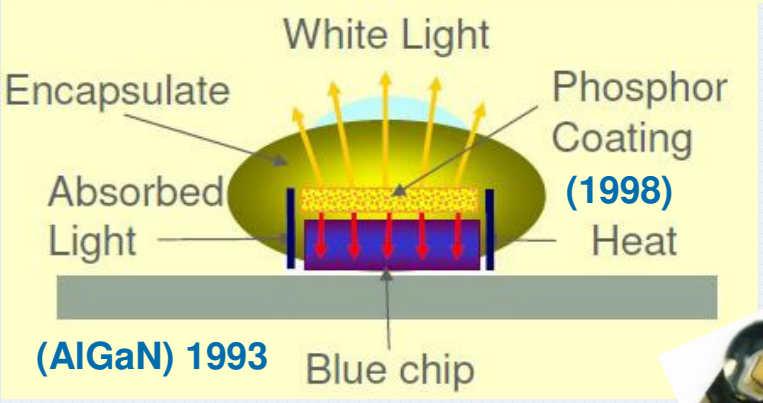
Efficiency in Light-Generation - LEDs

How do LEDs emit white light ?

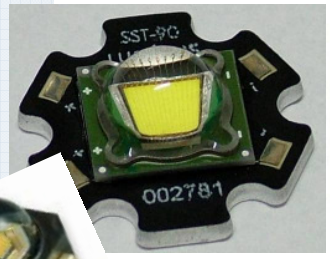


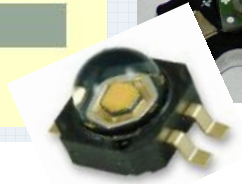
Mixed color process

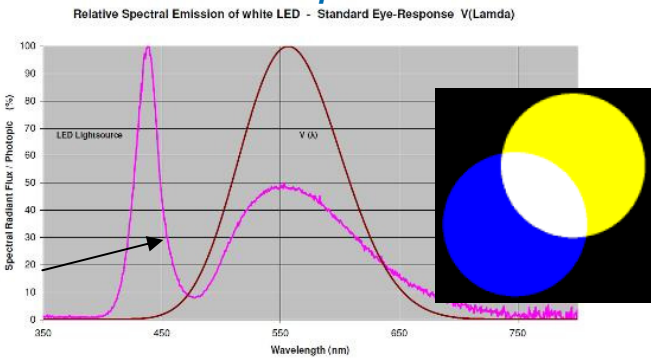
- RGB LEDs are mixed
- Dynamic color adjustment



Phosphor converted LED η ~ 100 lm/W



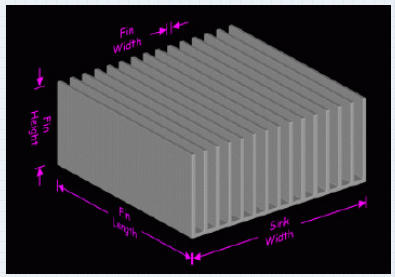




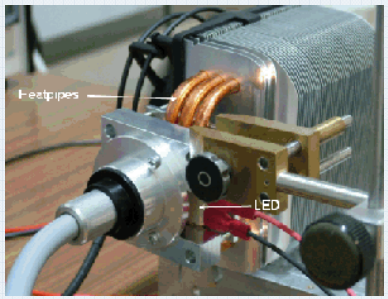
High white light point stability

Efficiency in Light - Generation

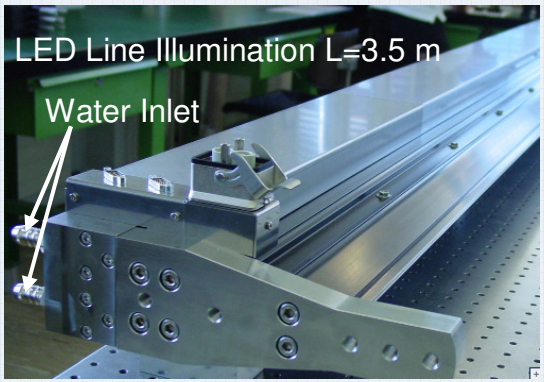
Cooling ⇔ important issue in LED-based systems



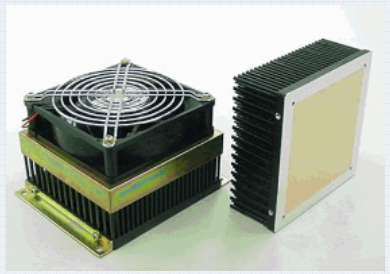
Convection



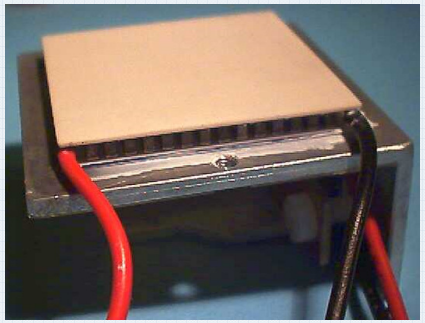
Heat Pipe



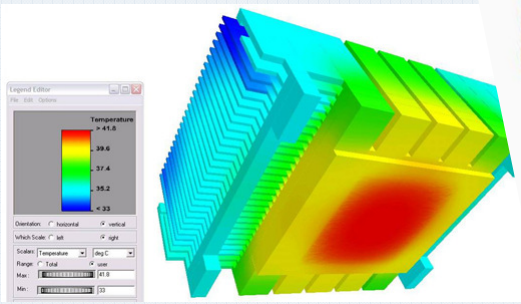
Water Cooling



Forced Air



Peltier

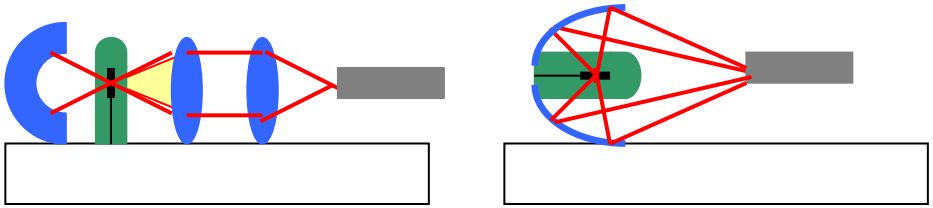


Thermal Simulation

Efficiency in Light Capturing

Efficiency in Light - Capturing

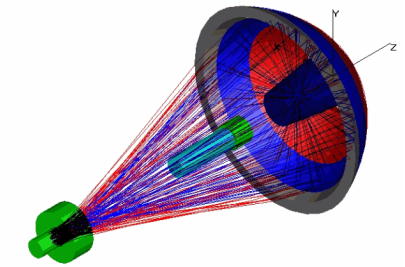
Conventional Light Collection (Halogen Lamps)



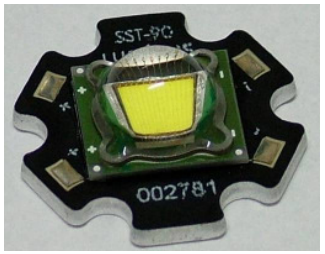
30 – 40 % of emitted light is collected

More efficient optics can not be applied near the hot lamp

Medical Lightsources ➔ Replacement with LED-Lightsources



⇔

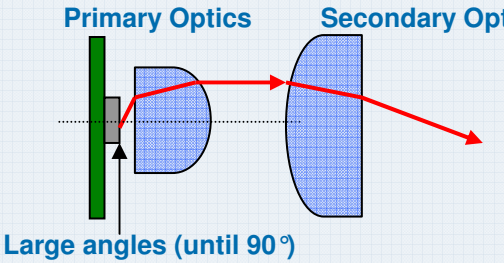


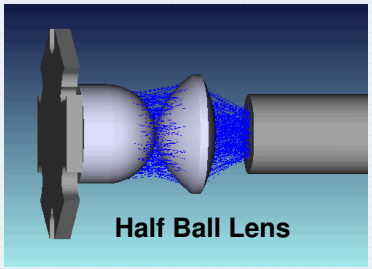
Xenon : 100W,180W, 300W
Metal Halide : 50W
Halogen : 150W

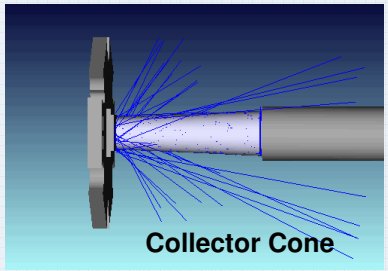
Efficiency in Light - Capturing

Light Capturing with LEDs ➔ *can be much more efficient !* η ~ 80 – 85%

Collector-Lens Concept :

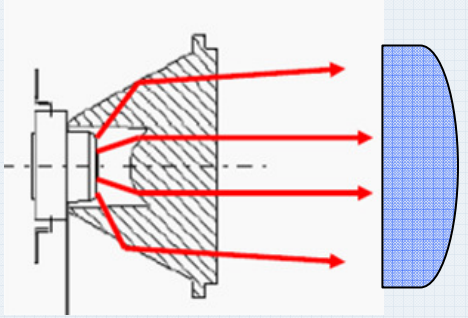


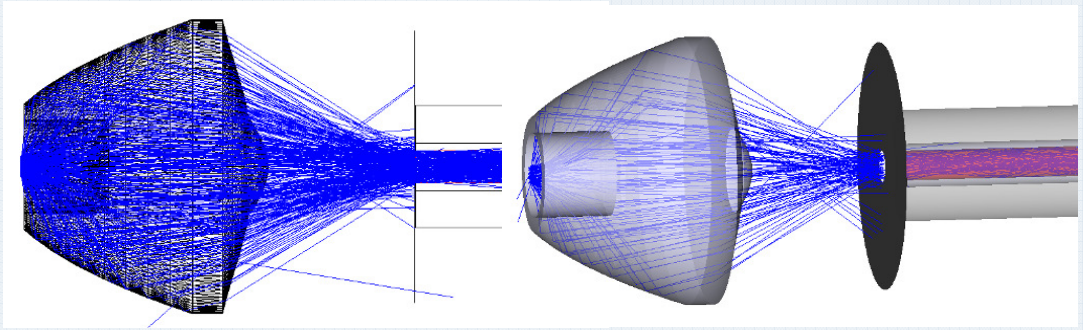




TIR-Lens Concept (PMMA) : Efficiency : ~ 80-85 % of emitted light is collected

Fiberoptic concentrator

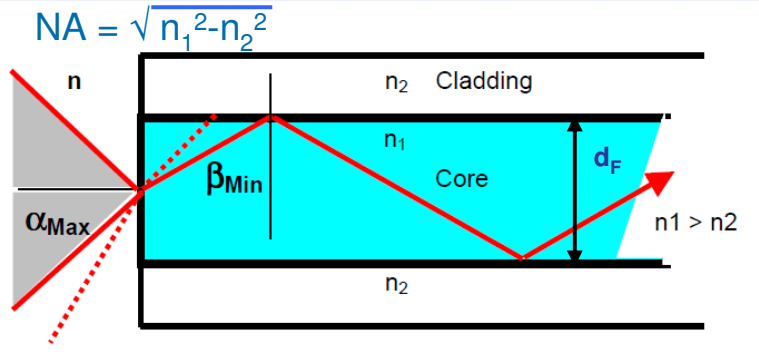




Efficiency in Light Transmission

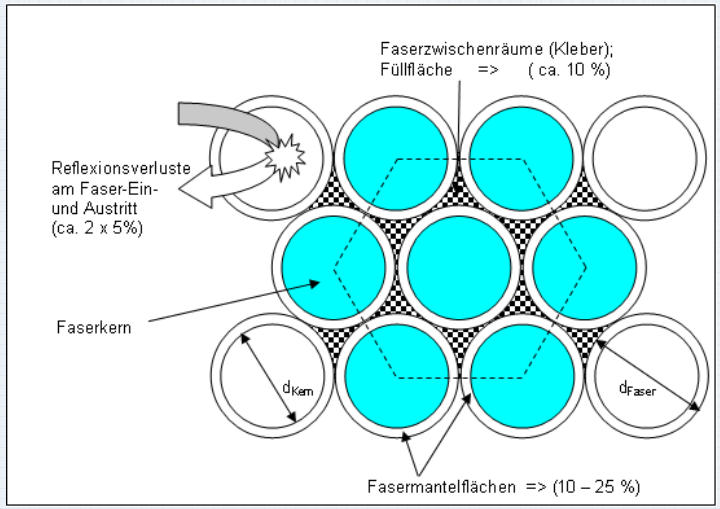
Efficiency in Light - Transmission

Optical Properties of Fibers



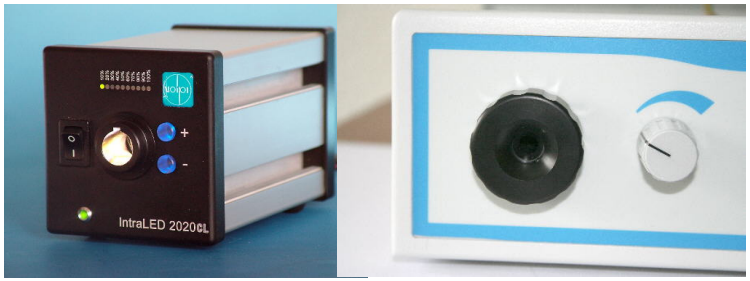
Optical Fibers :

- highly flexibel
- electrically isolating
- thermally isolating
- spectral transmission depends on materials (glass, quartz, plastic)
- different quartz-materials for UV and IR-Transmission



Reduced Bundle Transmission due to packing and cladding (ca. -40% @ 1m length)

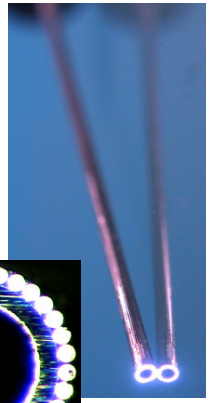
Volpi Lighting - Products

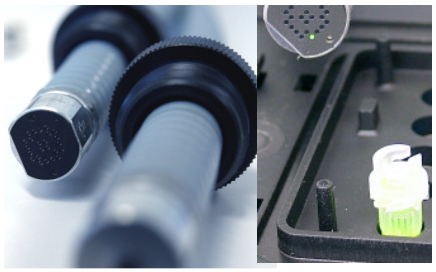


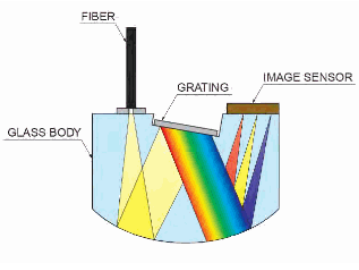
LED Lightsources / Lightsource-Modules

- endoscopic illumination
- intraocular illumination

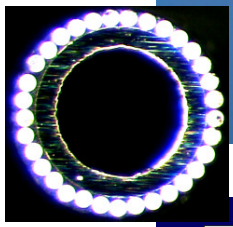
…. if necessary processor controlled



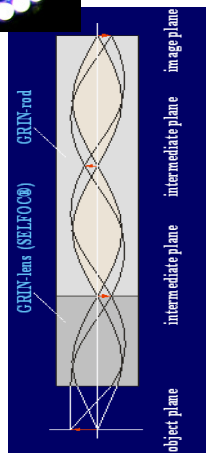




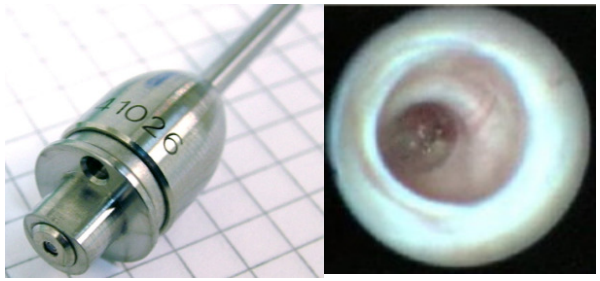
Fiberoptic products



- Life Science
- Light delivery to grating spectrometers
- Monitoring systems / components



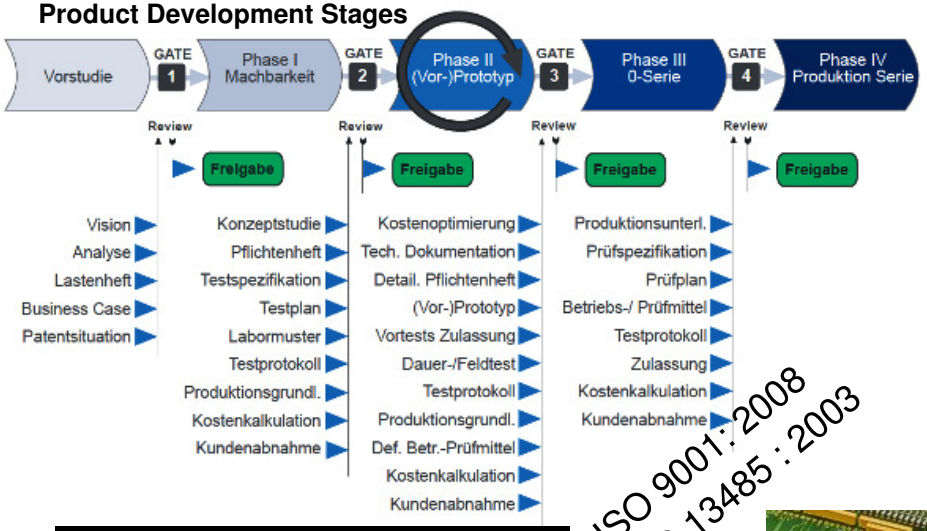
Thin endoscopes



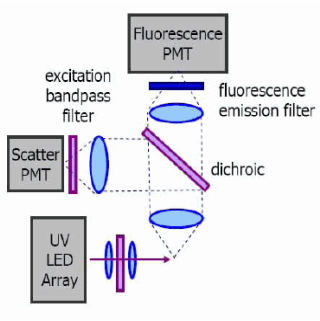
- Ductoscopy
- Anesthesy
  (image controlled intubation)

Volpi - Engineering

Product Development Stages

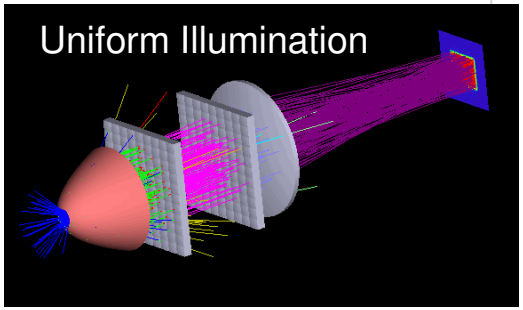


ISO 9001: 2008
ISO 13485 : 2003



Experience

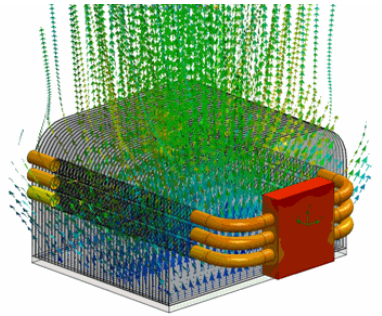
Filters
PMT-Detectors
Optics
LEDs
Lightguides ..



Optical Tools:
Zemax, TracePro

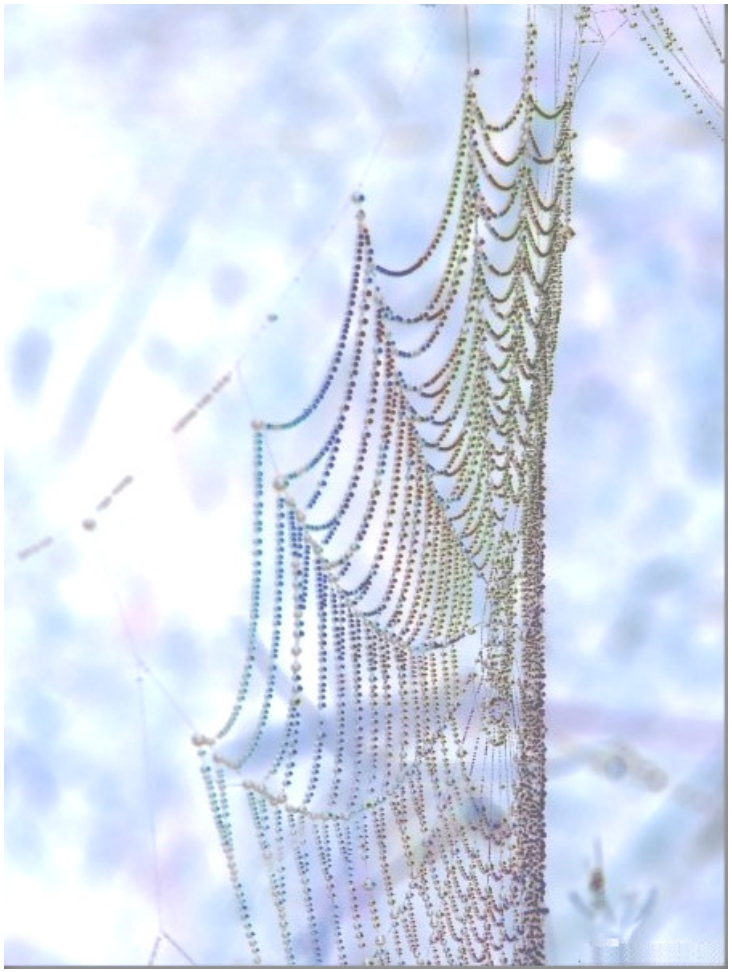
Processor controlled systems

Orcad; C++; LabView
Platform: CORTEX M3



Mechanics / Heat Transfer

CAD: 3D-SolidWorks
Flow-Simulation



Thank you

for

your Attention