FISBA Innovators in Photonics

More light into medical fibers

A sequel …

Laabs, H., Mehl, O. and Rehn, H., “Mehr Licht aus kleineren Fasern,” Biophotonik **1**, 3 (2016).

Mehr Licht aus kleineren Fasern

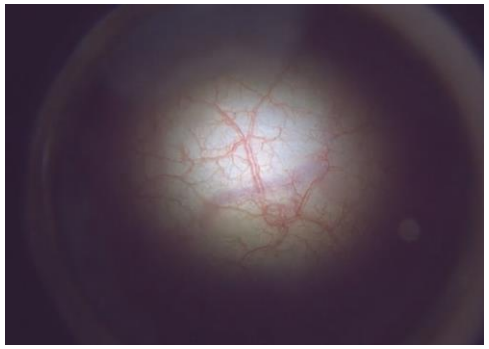
Neue Lichttechnologien ermöglichen nicht nur Faserlichtquellen mit höherer Effizienz und größerer Lebensdauer sondern auch kleinere Faserdurchmesser. Insbesondere in der Endoskopie und industriellen Messtechnik ergeben sich neue Anwendungsmöglichkeiten.

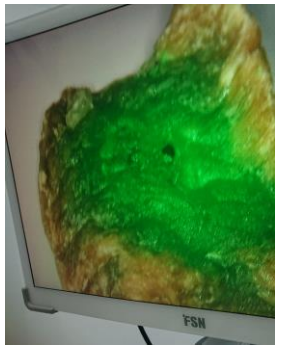
Holger Laabs, Oliver Mehl, Henning Rehn
OSRAM GmbH

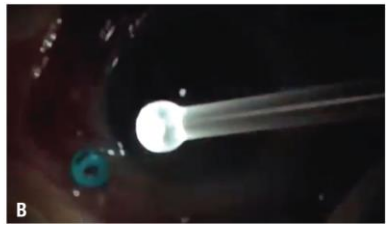
Kabel für Hochleistungslaser sind kommerziell für optische Strahlungsleistungen von z.B. 20 kW verfügbar [3]. Im Lichtleitfasern in Kombination mit Kaltlichtquellen ist die Lichtquelle zur Reduktion der Wärmebelastung im Gewebe

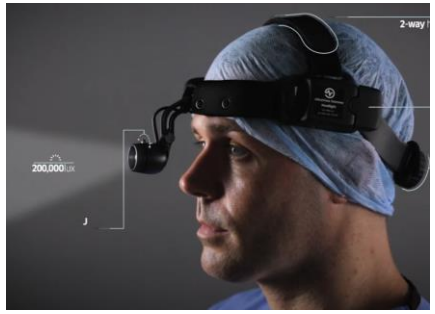
Applications of Medical Fiber Lighting

- Endoscopy :
  - Illumination
  - Fluorescence
- Ophtalmology :
  - Endoillumination
- Dental
- Microscopy
- Formerly : Surgical headlights









From source to fiber

a little calculus

- Target étendue (Fiber) $U_T = (\pi \cdot r \cdot NA)^2$ (mm²sr)
- Source Flux Φ_S (lm)
- Source Luminance $L_S = \frac{\Phi_S}{U_S}$ (cd/m² = Nit)
- Source étendue (LED) $U_S = \pi A$
- Collected target flux $\Phi_T = min\,(\Phi_S, L_S \cdot U_T)$

It‘s all about luminance !

Customer Wishes

necessary luminance

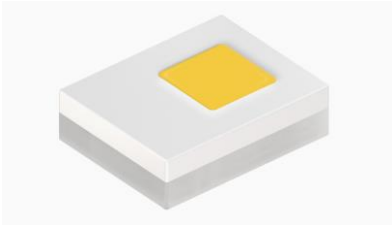
- 10 lm in D=100µm, NA 0.5

$U = 0.006\ mm^2 sr$ $L = 1620 MNits$

- …

„Brightest“ LED

300 MNits



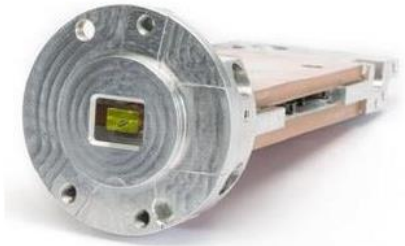
- 2400 lm in D=4.8mm, NA 0.37

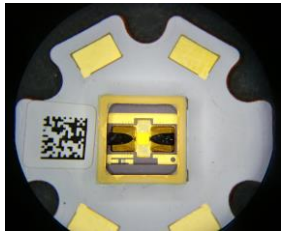
$U = 8\ mm^2 sr$ $L = 300 MNits$

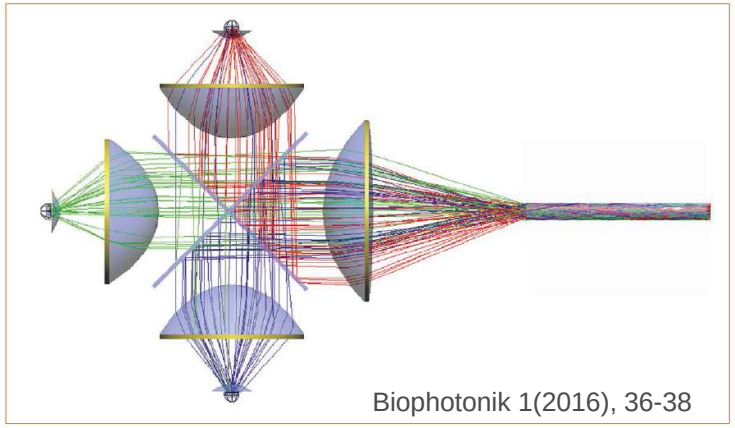
- CRI > 80, 4500 K, close to BB

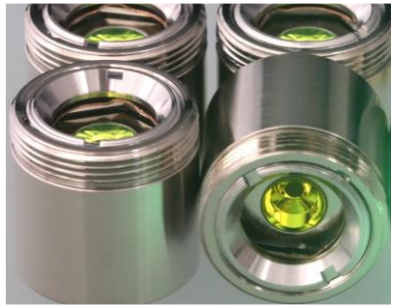
Source selection

High Luminance needed






Biophotonik 1(2016), 36-38



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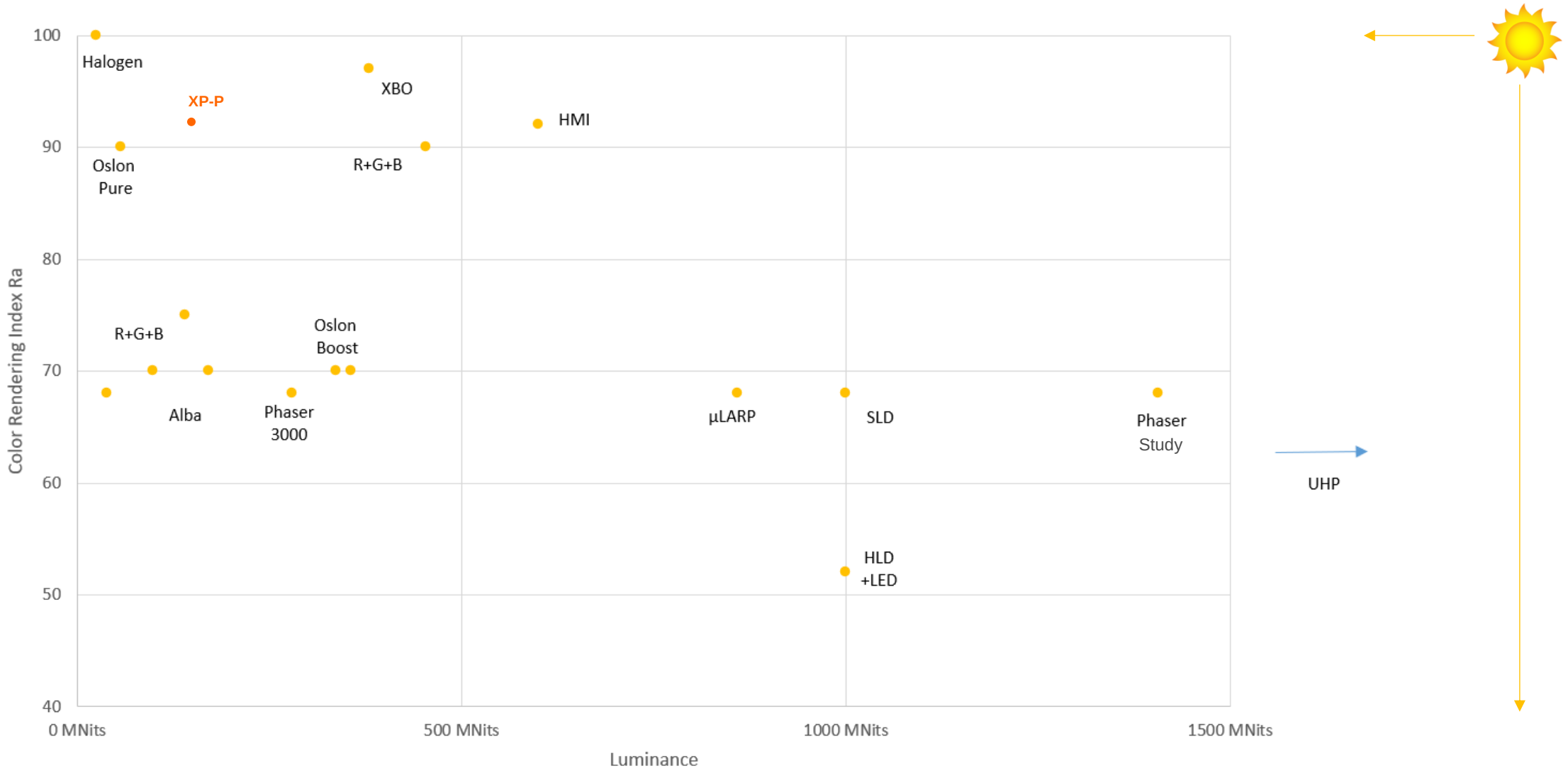
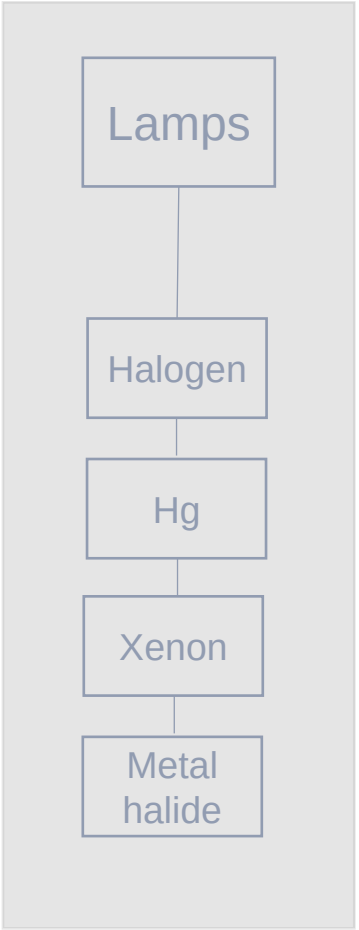
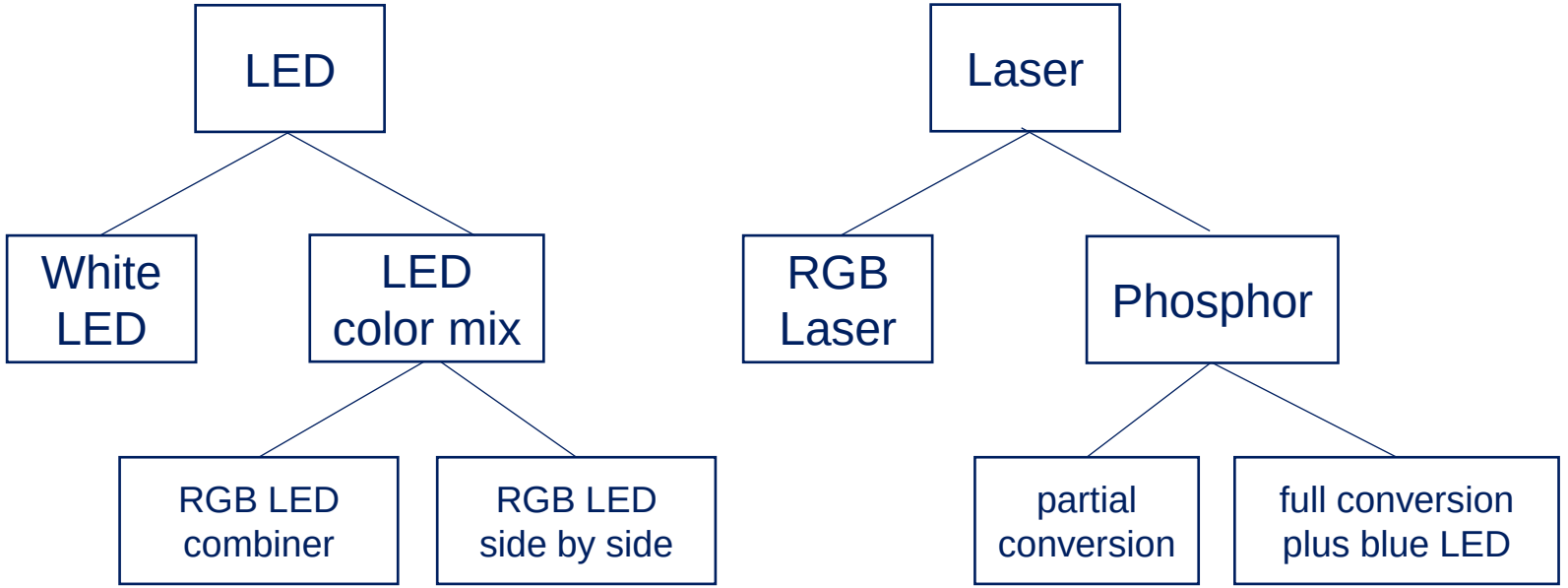
Color Rendering - Luminance Tradeoff



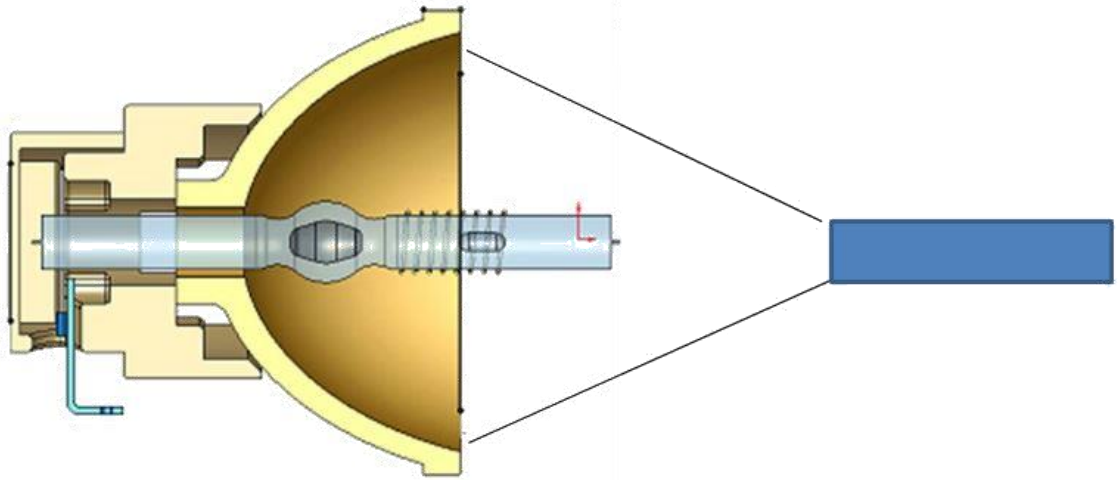
White Light Technologies

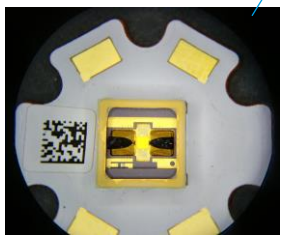


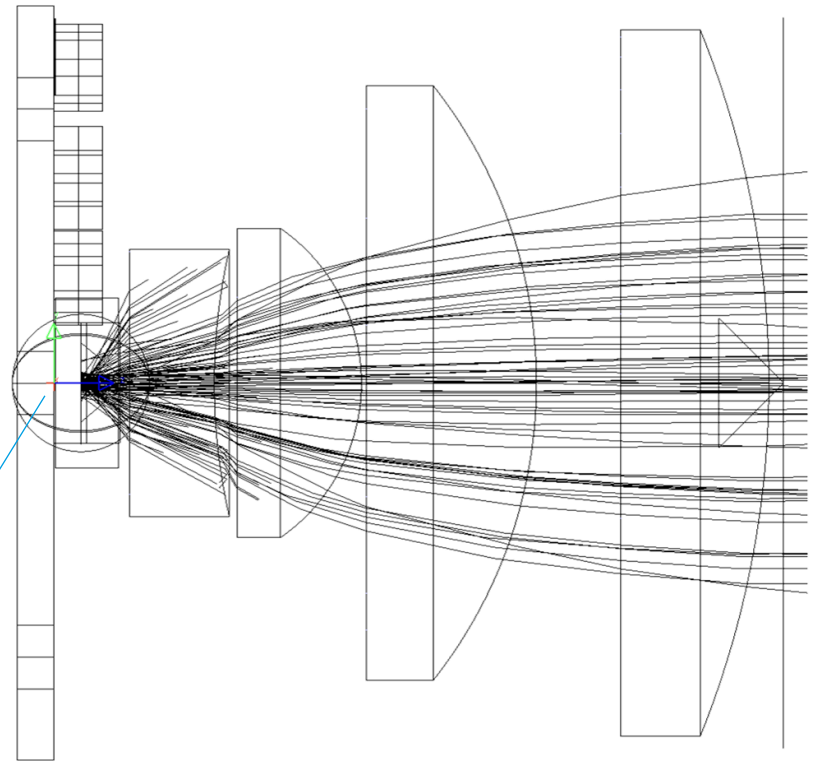


Optical design for light sources

Small target étendue : Preserve luminance !



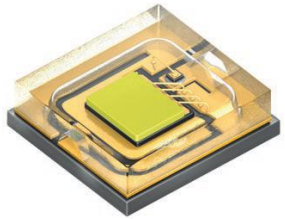


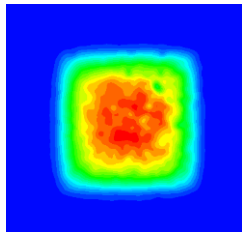


Source assessment

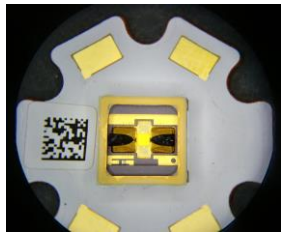
Where is my luminance ? Virtual focus and Rayfile Analysis.

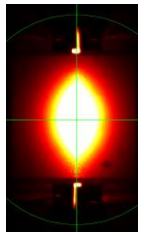
LED



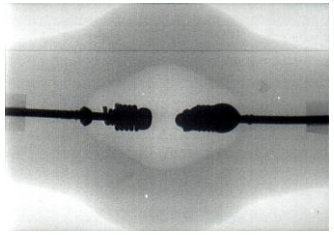


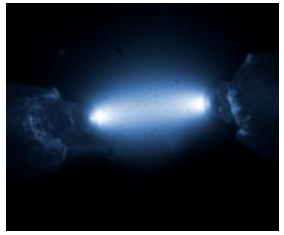
SLD

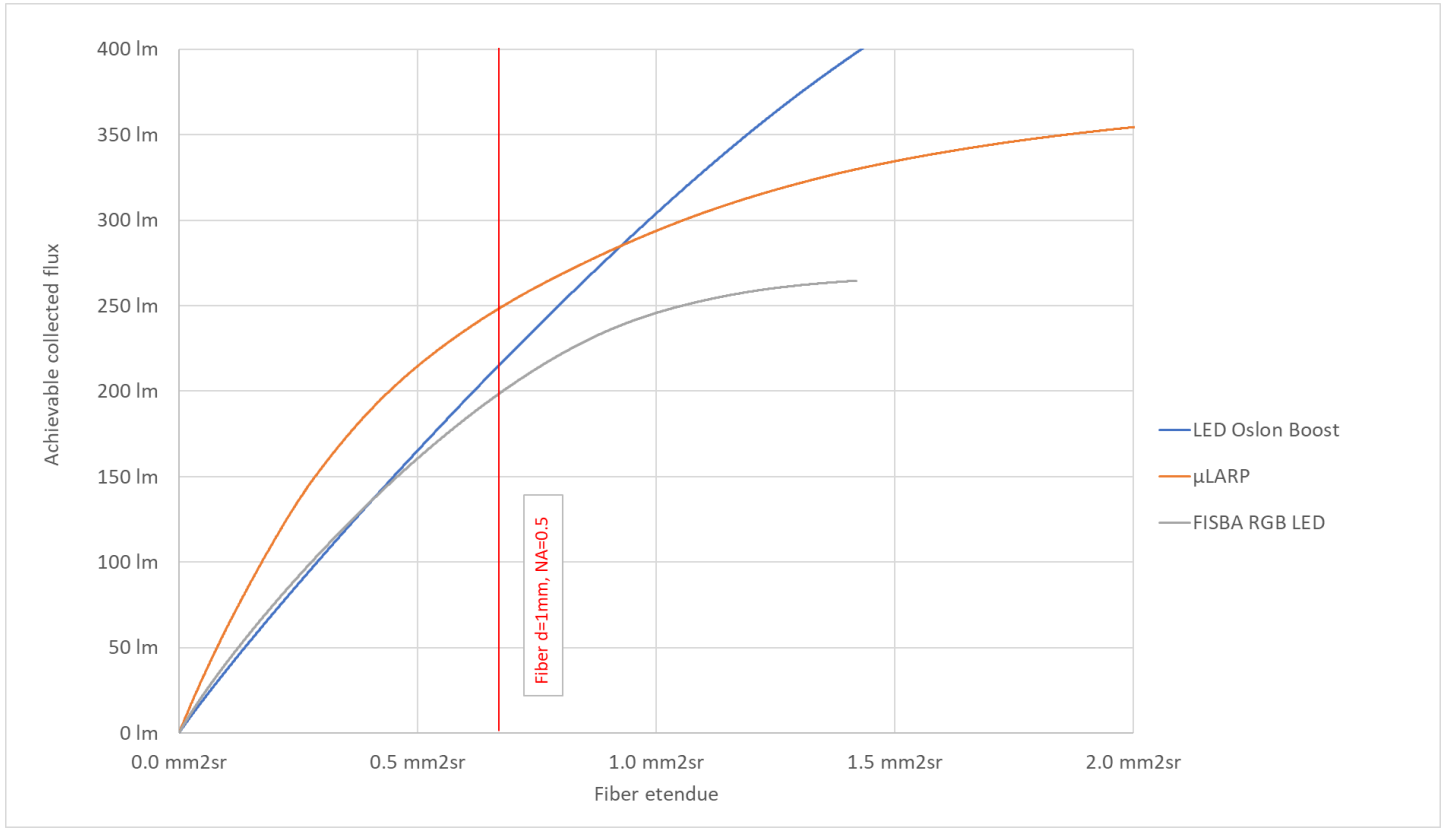




Discharge



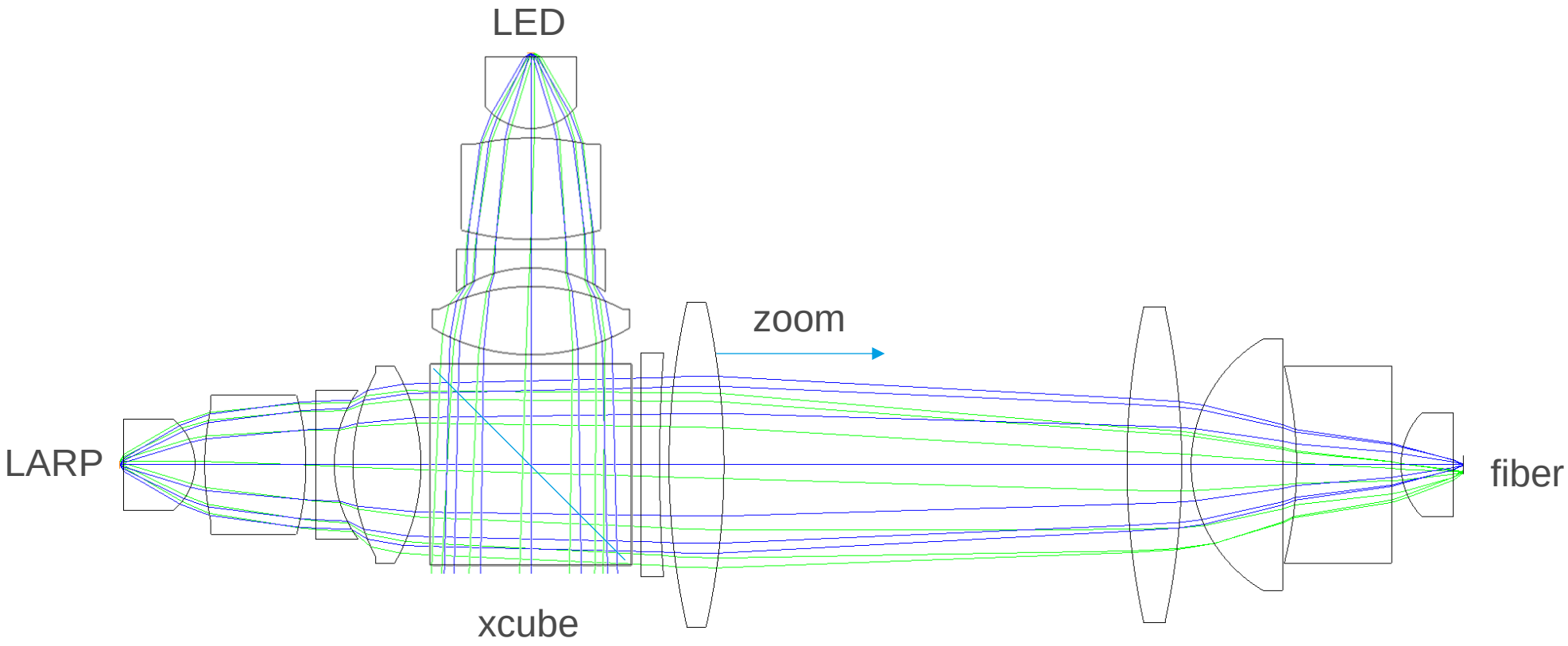




Luminance diagram based on source rays analysis

Design example

LARP source plus 780nm, tuneable beam angle



Summary

FISBA Innovators in Photonics

The specification determines the source technology.

Source luminance determines optics size and cost.

New LARP sources available.

Mostly imaging optics.

There are always tradeoffs.

References

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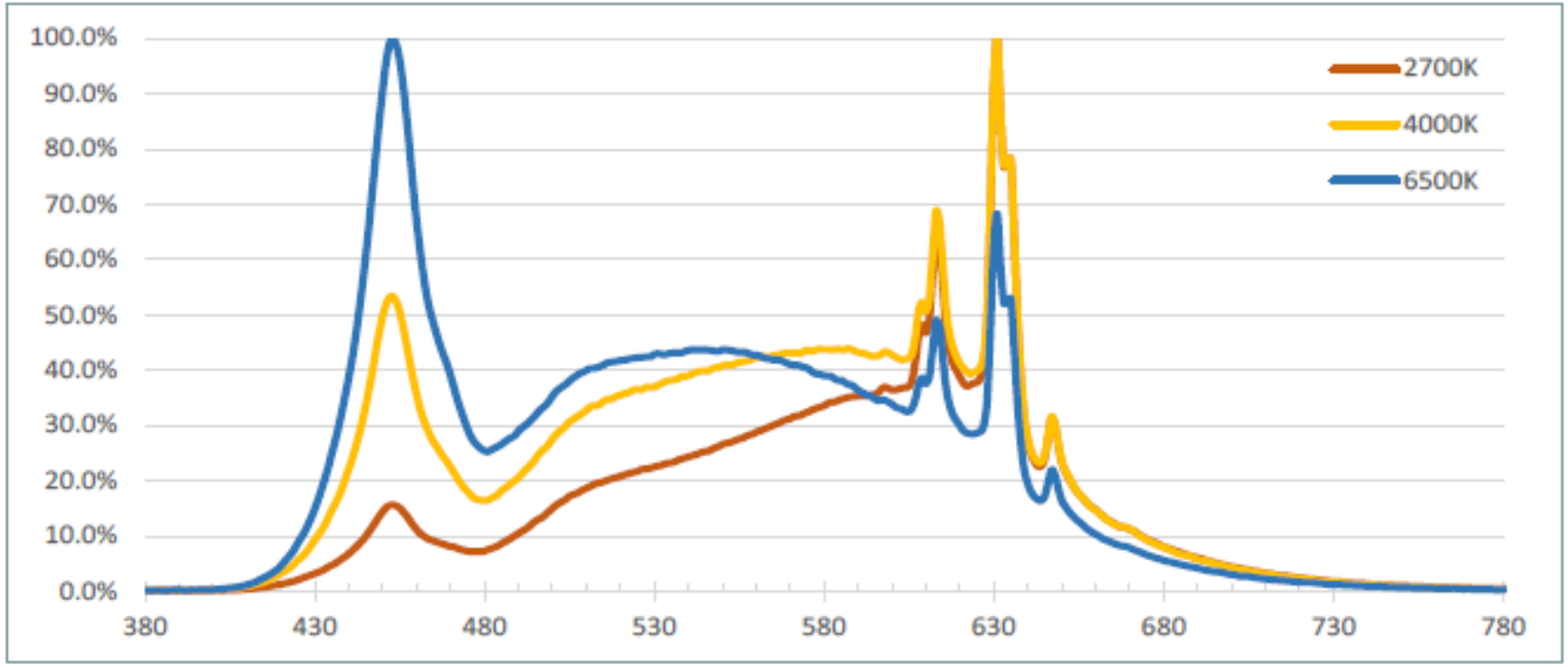
- Muschaweck, J. and Rehn, H., [Designing Illumination Optics] (2022)

Color rendering

A measure for light quality. Newer (better) standards not yet widely used.

More Red ?

LEDs by Luminus Devices



also for LARP ?

CRI : the notch filter hack

US 2013/0170199 A1