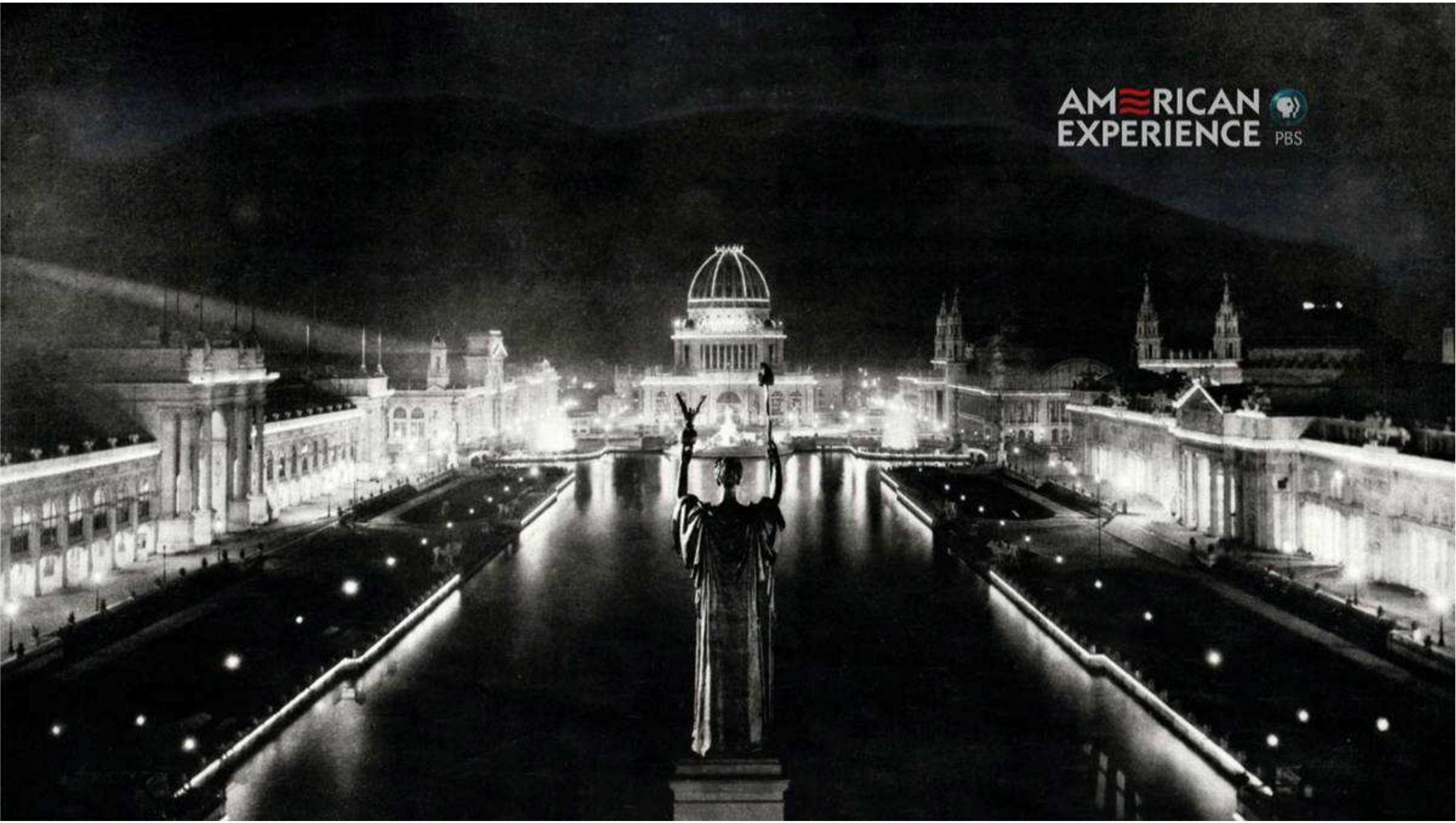
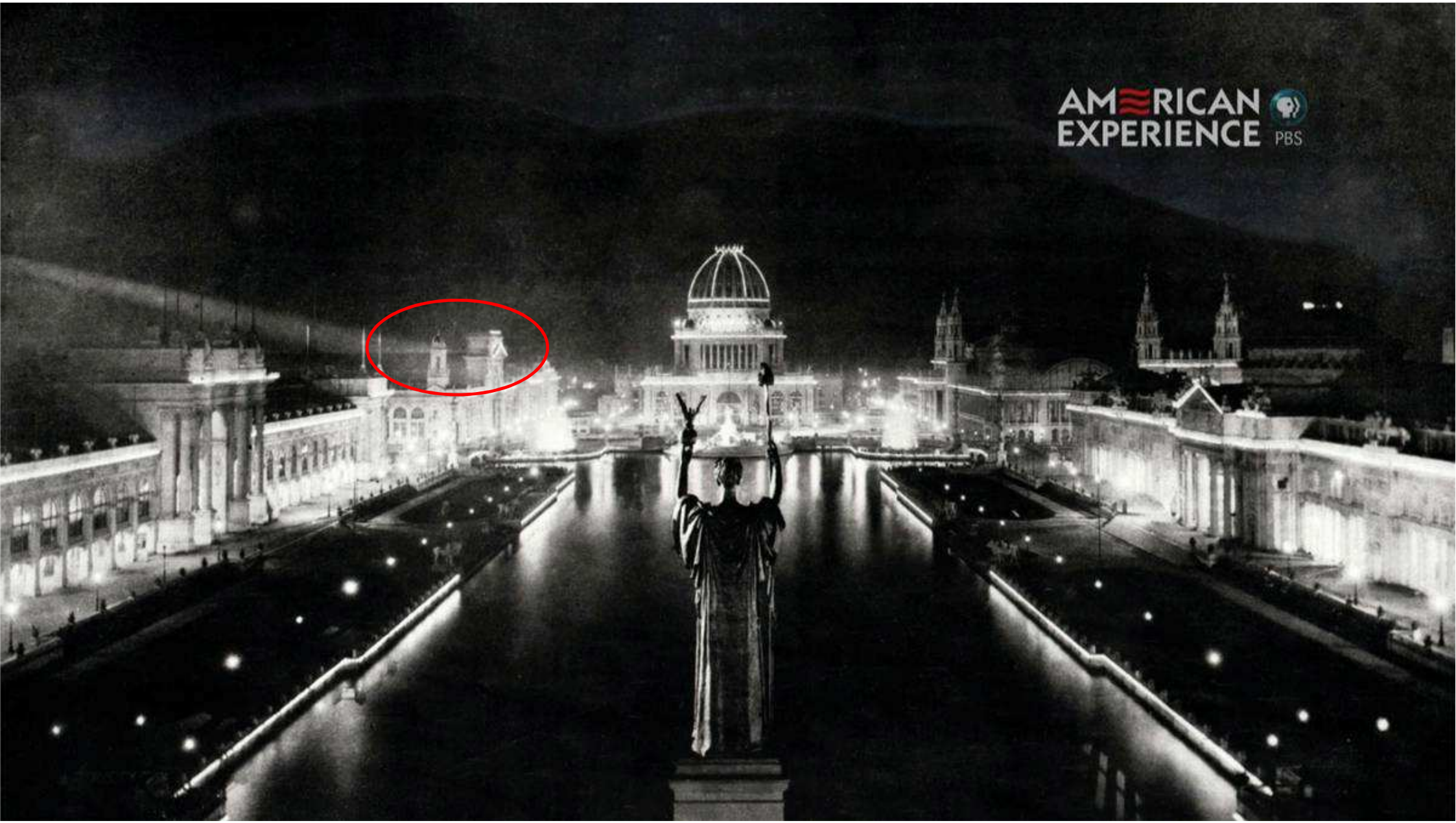
PERFECT PARTNERSHIP


AMERICAN EXPERIENCE
PBS


AMERICAN EXPERIENCE
PBS

OPENING THE VAULTS

WONDERS OF THE 1893 WORLD'S FAIR

Johann Siegmund Schuckert – 1893 Chicago

LED High Capacity Floodlight

When will be the 2000 W class ready?

Frank Wieland Roedel
OSRAM/Siteco Beleuchtungstechnik GmbH
Produktmanagement Sport & Area Lighting

High End Optic

LENS versus Reflector

Colour Rendering

Maintenance – ONE WIRE

CINEMA Standard

POWER

Perfect Picture

Dynamic Temperature Control

LENS

versus

REFLECTOR

Optic – Lense – Optical Concept

- Spray Lighting (PCB brightening)
- Less light in critical directions (light immission)
- Good optical efficiency with optimized LED and Lense size
- Defects cause a loss of efficiency
- Spray lighting leads to warming of the optical system
- Lens arrays can be set to multiple surfaces

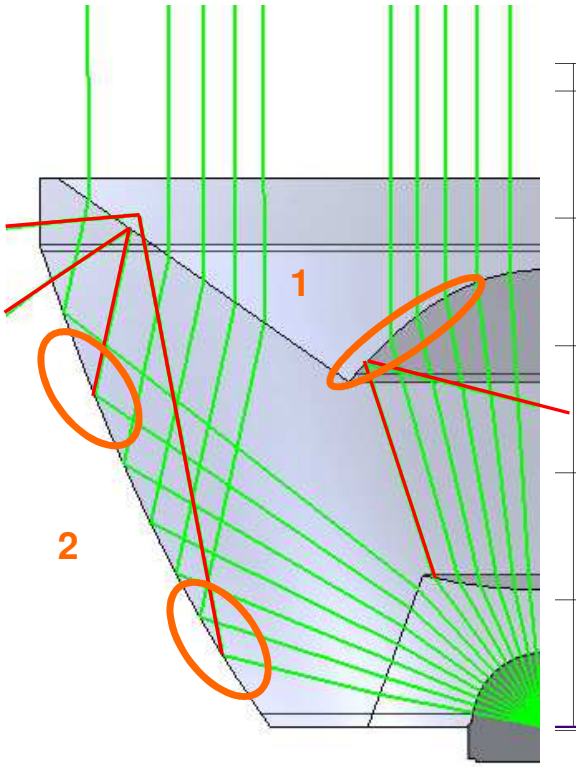
Opt. Design

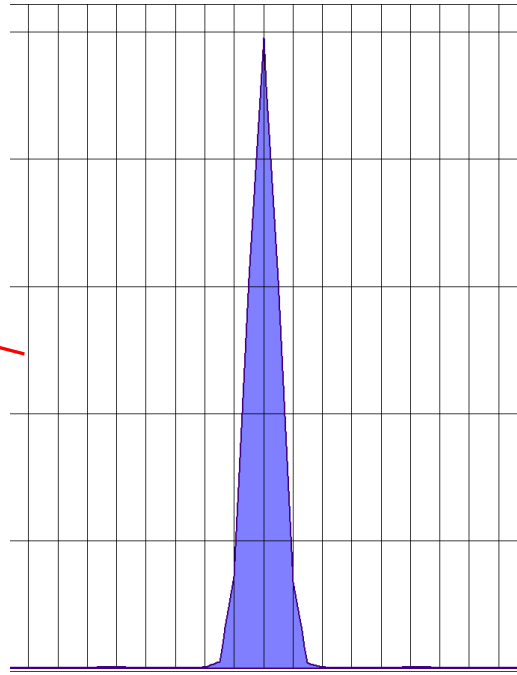
Efficiency

Spray Lighting

TIR-Linse (without end cover)

1 Fresnel-Reflexion
2 Defect

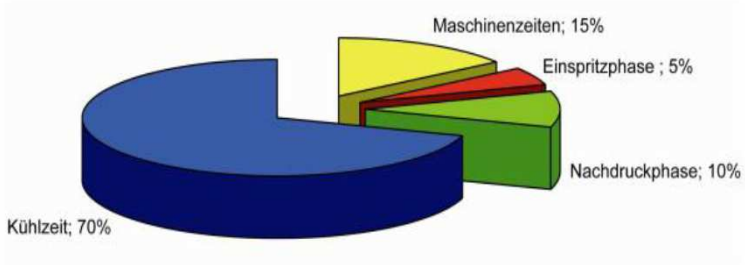


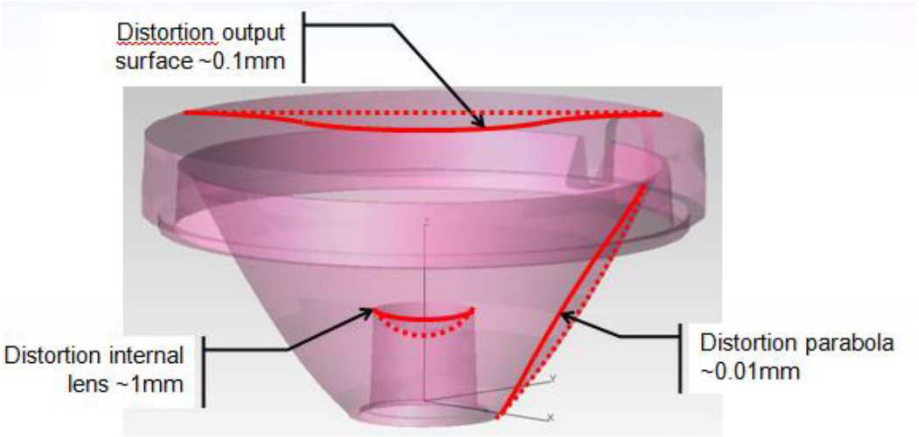


Optical Efficiency up to 90 %
(without cover)

Optic – Lense - Production

- Cycle time depending on cooling time
- Injection molding defects (e.g. blows) are increased by increased material thickness





Difficulty:
Large lenses

Disadvantage
in production regarding
Large lenses

Optik – Lense - Production

- Precise tolerance analysis and tolerances necessary, especially for lens arrays, due to the different thermal expansion of plastic and PCB material

Difficulty:
Large lenses

Disadvantage
in production regarding
Large lenses

Advice: Test 0,1mm shifted Lense to PCB/LED
Measurement: 15% lower Imax.

Optik – Reflector – Optical concept

- Very high optical efficiency with silver coating
- Low share of spray light
- Problems with free radiation
- Limited optical design
- Higher cost of production compared to lenses

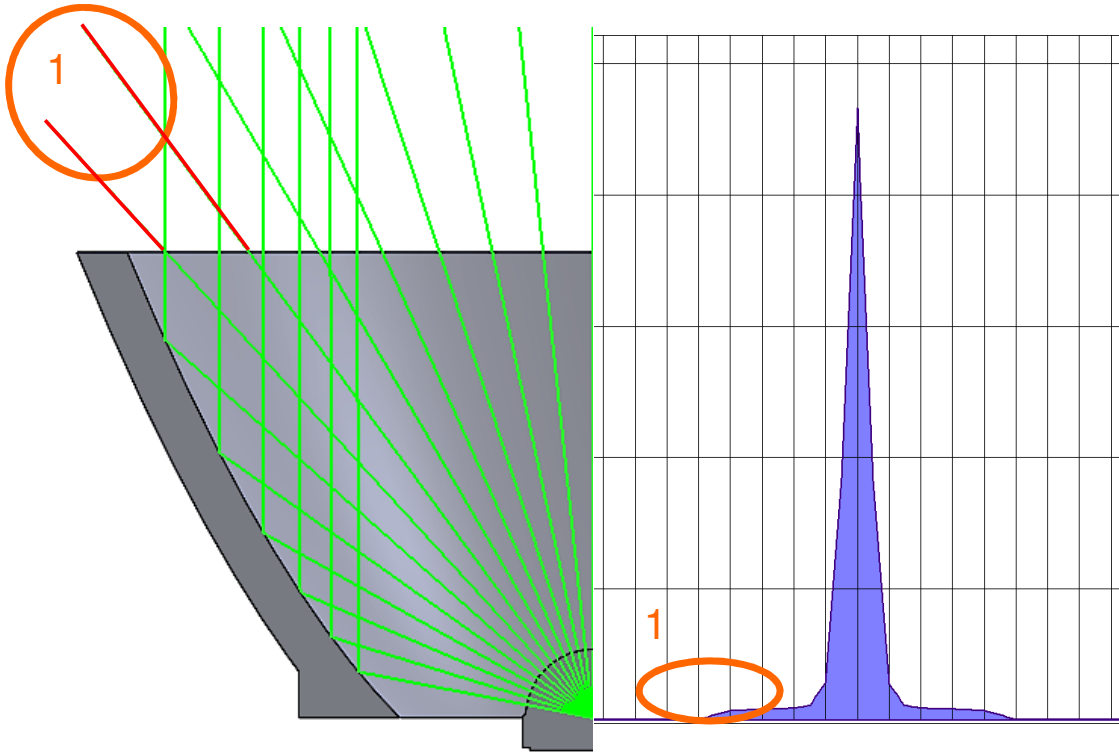
Optical efficiency

Low share of spray lighting

Reduced optical design opportunities

Reflector (without cover)

1 Free Radiation



Optical efficiency: ~ 96 %

without Glas (silver reflector)

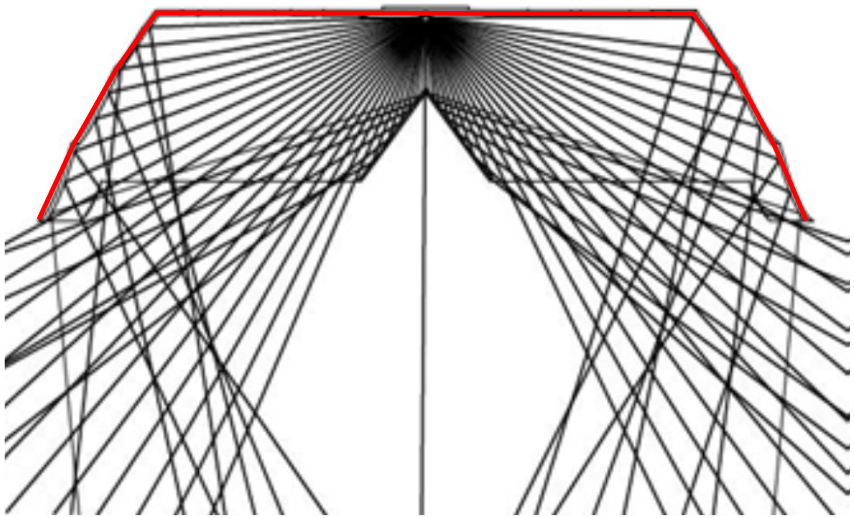
Optical concept – Lense - Production

- Constant and low wall thicknesses, therefore shorter cooling times and less injection molding defects like sink marks and flow lines
- These are additional, complex production steps for applying the silver coating.
  Coating protective layer necessary

Large reflectors are possible

Less production problems

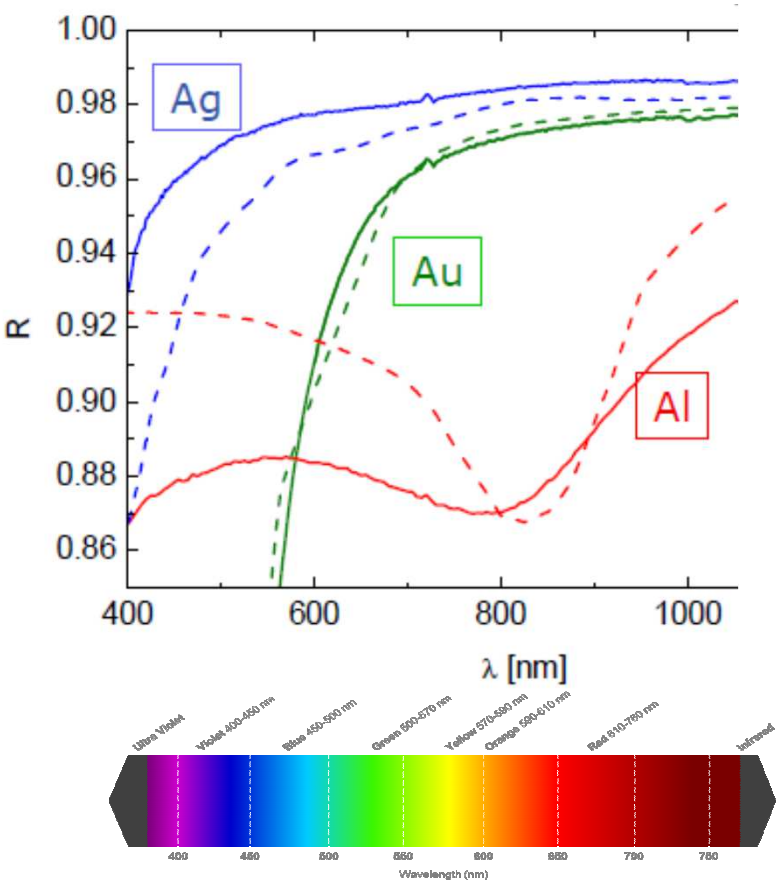
Complicated silver coating process



Reflector Coating– Gold - Silver or Aluminium

Ag: Silver
Au: Gold
Al: Aluminium

Silver Reflector – up to 11% higher reflection degree compared to Aluminium reflectors



Lense reliability

PMMA Lense
Advantage: high Transmission
Disadvantage: Problems due to temperature and blue spectrum

Silicon Lense
Advantage: high Transmission and good stability regarding temperature and blue spectrum
Disadvantage: high costs / construction efforts-
Expansion at higher temperature entry

Glas Lense
Advantage: high Temperatures, very good transmission, no aging
Disadvantage: limited in design

Polycarbonat Lense
Advantage: high temperatures
Disadvantage: UV-Stability - yellowing

Foto: Polycarbonat Linse – Vergilbung nach Temperatur & Blaueintrag

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Foto: Silikonlinse

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Foto: Glaslinse

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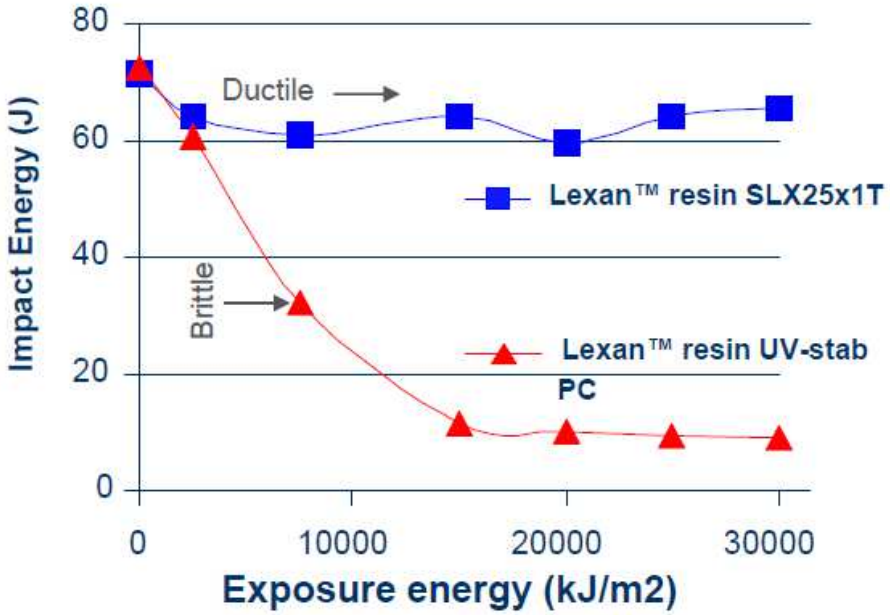
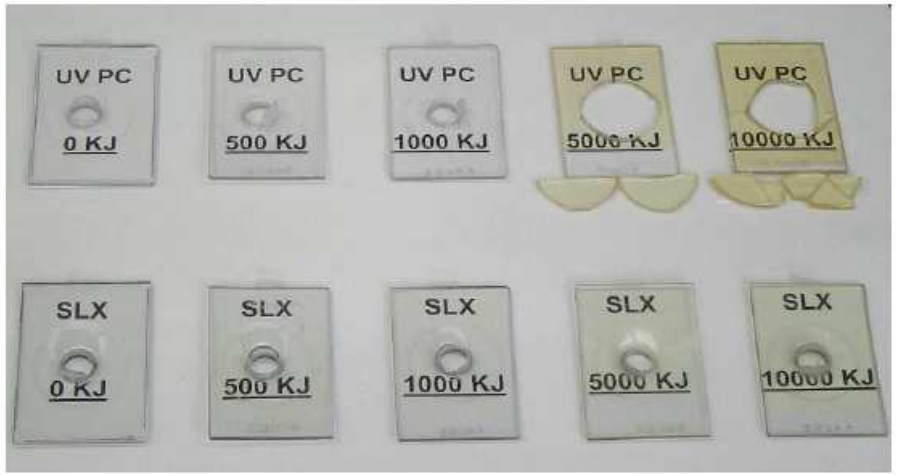
Polycarbonat Lense
Advantage: high temperatures
Disadvantage: UV-Stability - yellowing

Foto: Polycarbonat Lens Array

Polycarbonat Lense
Yellowing by UV radiation





Xenon Arc Exposure

Colour Shift

Lexan™ SLX Resin: Better Retention of Colour, Transparency, Ductility than standard UV PC Resin

Quelle: Lexan – Eingetragenes Warenzeichen Thyssen Krupp

Durability Reflector

Reflector

Advantage: simple production process even with larger optics

Disadvantage: *Elaborate cost-intensive manufacturing process*
Coating process must be monitored permanently

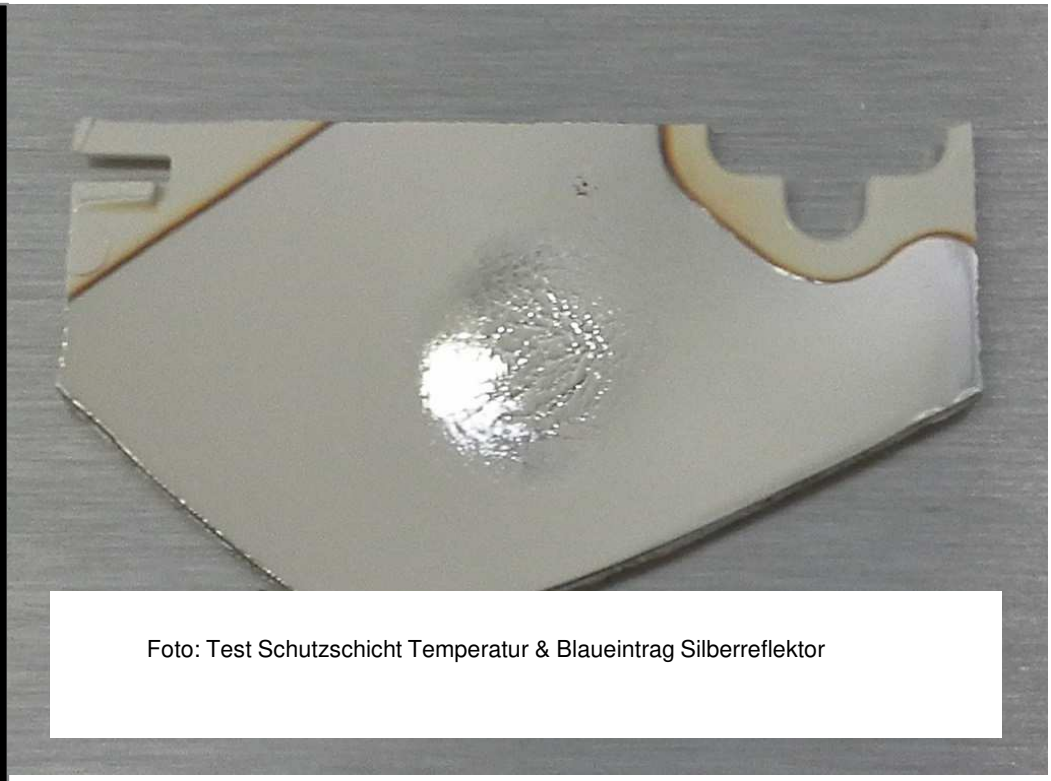
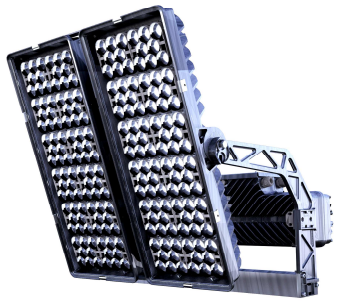


Foto: Test Schutzschicht Temperatur & Blaueintrag Silberreflektor

Result – Lense versus Reflector

Optic / Production / Costs:
Small luminaires or asymmetrical floodlights
Recommendation: PMMA Lense with glass cover

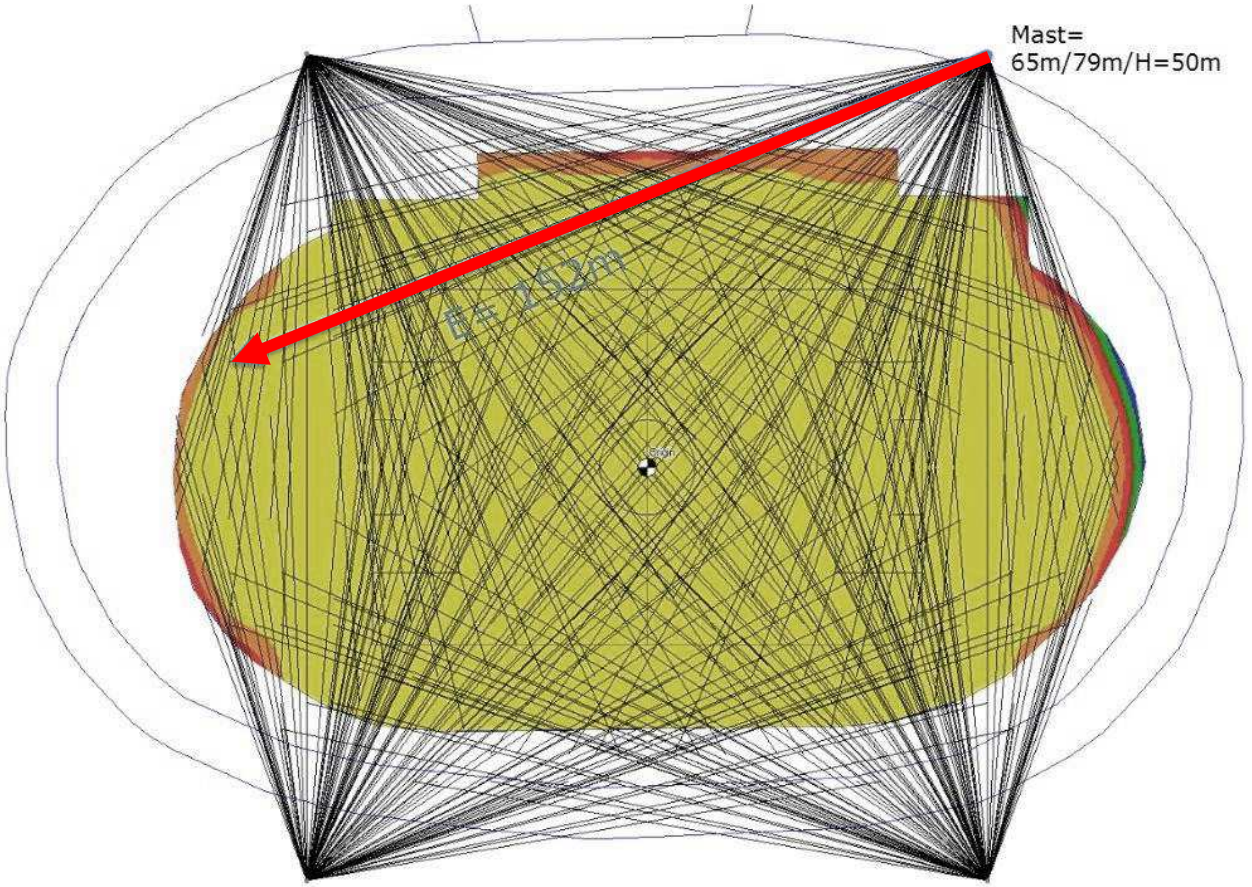
Optic / Production / Costs:
Large symmetrical or asymmetrical floodlights
Recommendation: Glaslenses for asymmetrical floodlight and silver reflectors with glass cover for symmetrical floodlights




High End Optic

Place of use for rotationally symmetrical high capacity floodlights

- Four mast system
- Floodlight distance 152m
- Narrow beam floodlights are required



Full Cut Off Floodlight

Full Cut Off Floodlight

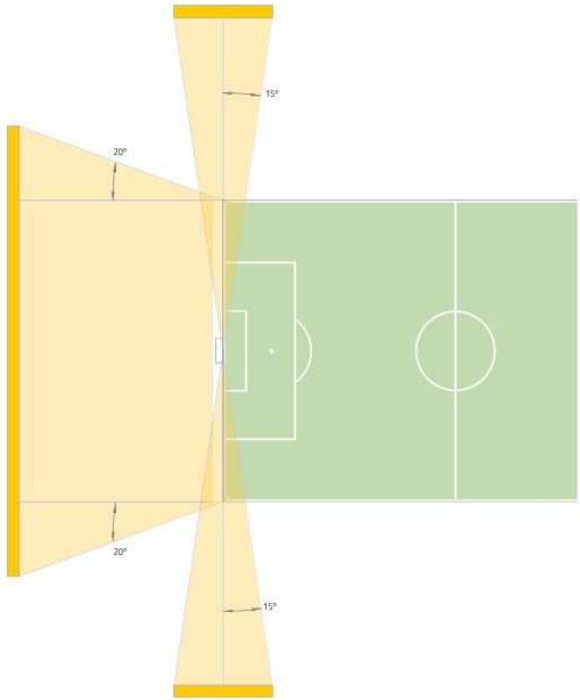
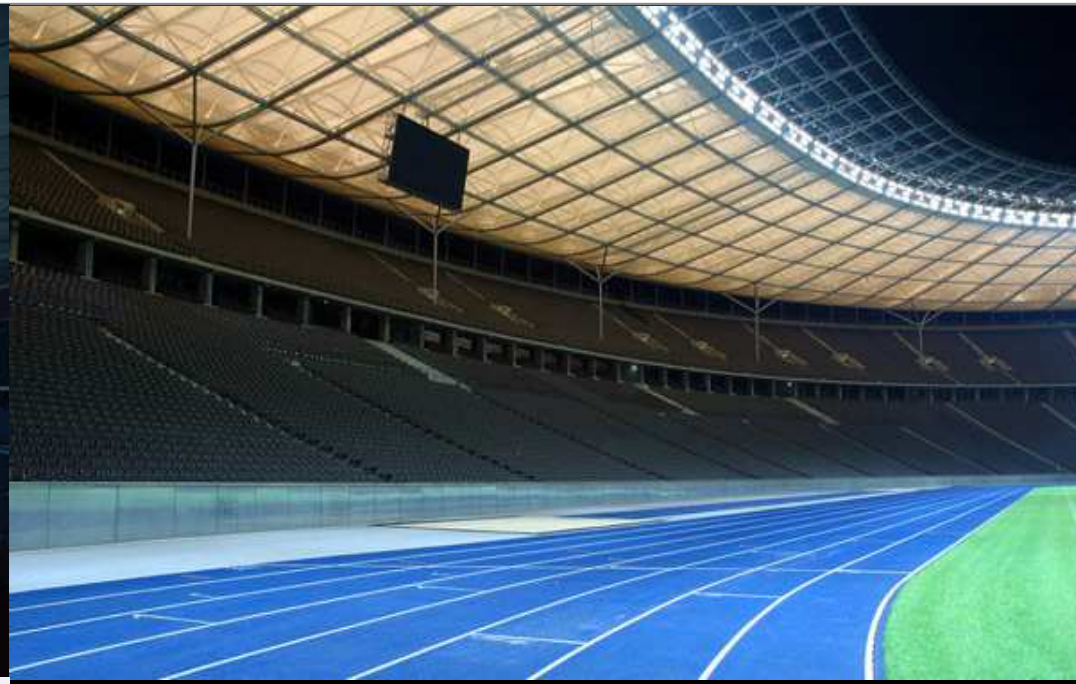
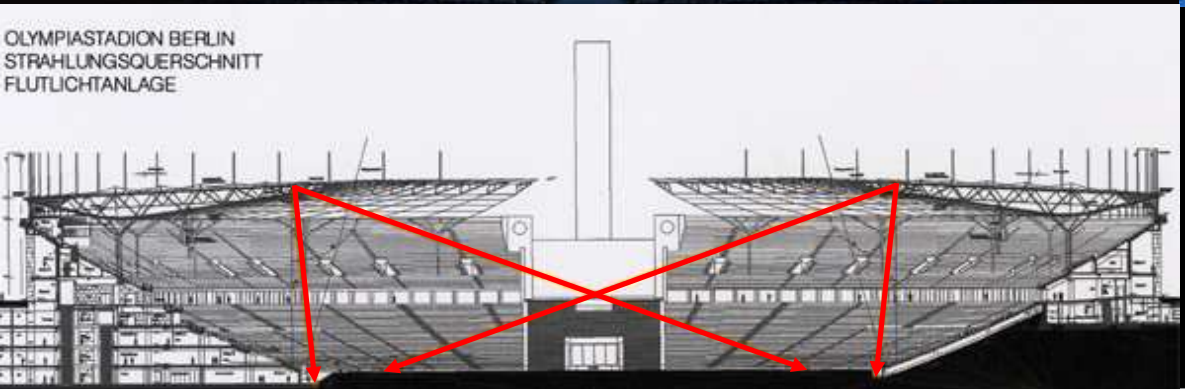


Diagram 9e:
Floodlight glare

- No floodlights
- No floodlight zone

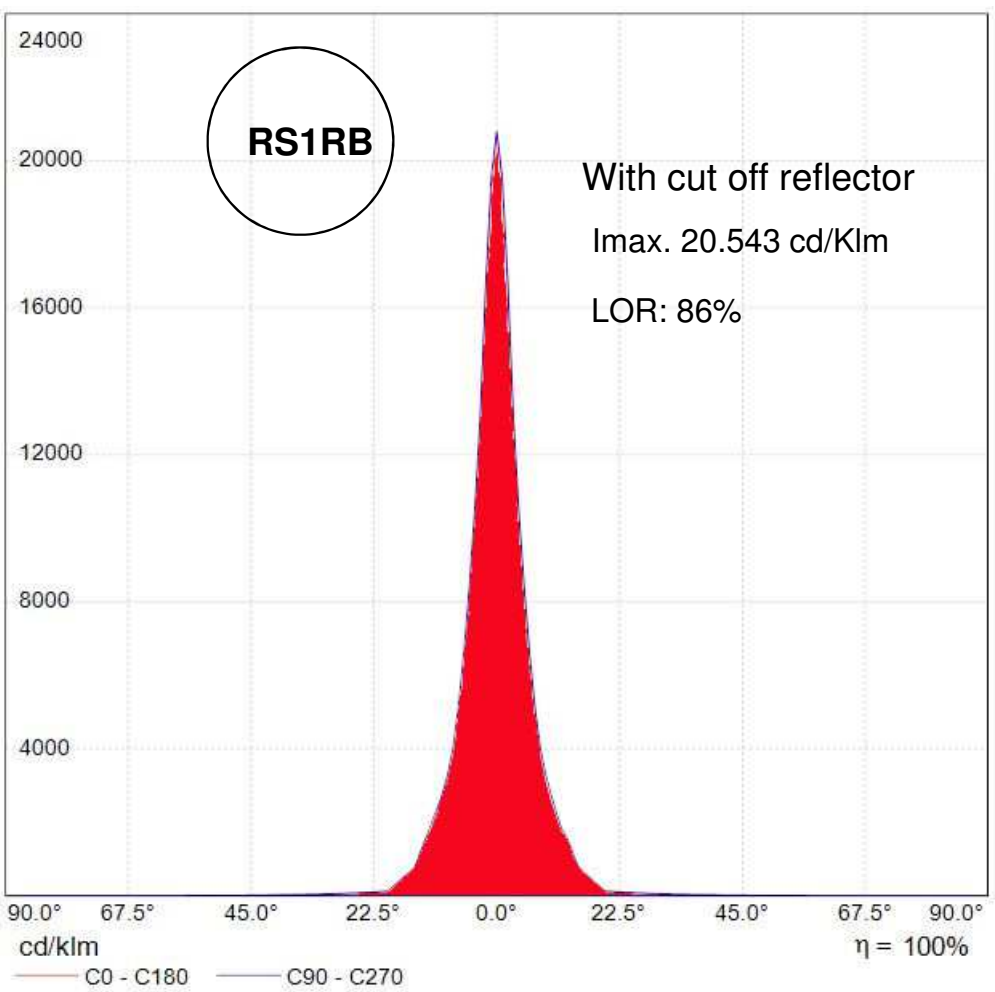
Full Cut Off Floodlight

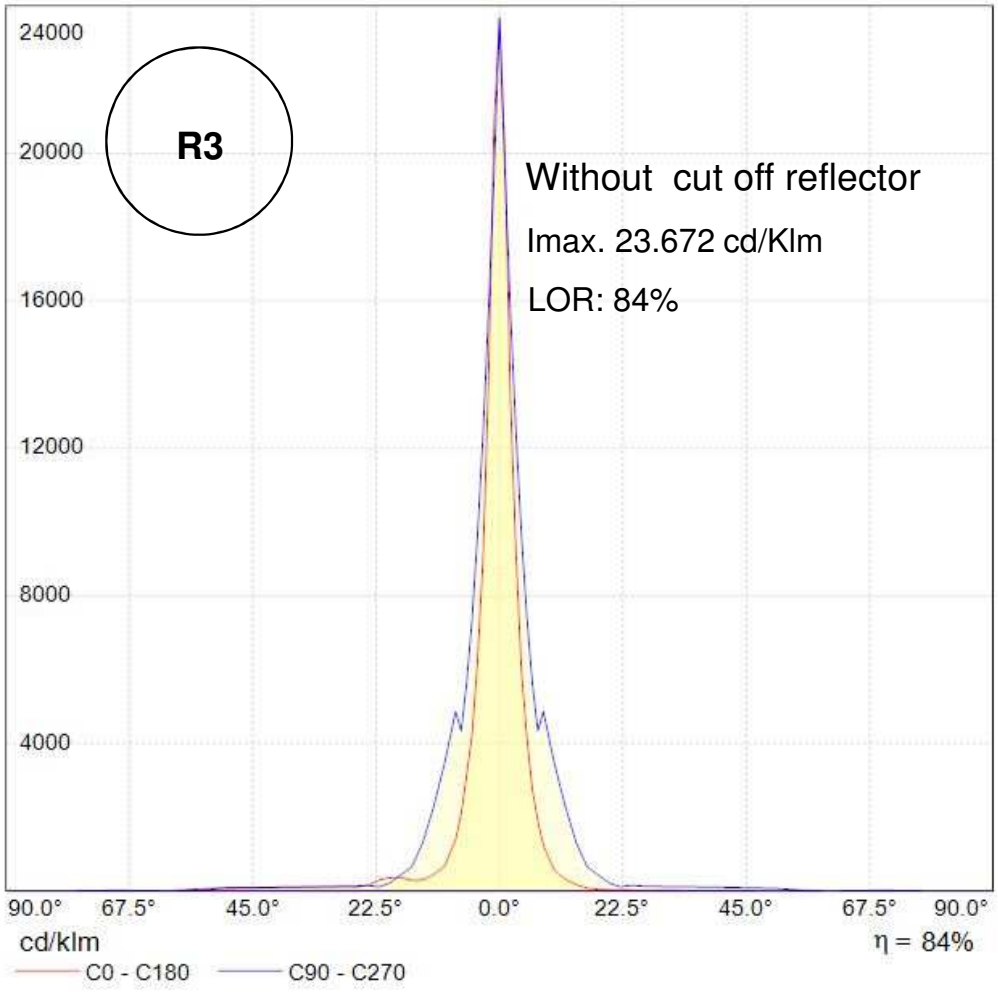




Olympiastadion Berlin

Optic Reflector – Optimization with cut off reflector





Optic – Cut off Reflector

Without Free Radiation

Free Radiation

RS1RB

With reflector shield

R3

Narrow Beam 11

Optic – Cut off Reflector

>Energy

~ 10% better performance with Cut off Reflector

<Energy

RS1RB

With reflector shield

R3

Narrow Beam 11

Colour Rendering

UEFA / FIFA – Recommendation – Colour Rendering Index

UEFA Level A Stadium > 2000lx

Colour temperature (Tk)	5,000–6,200K
Colour rendering	≥ 80 Ra

≥ 80 Ra

FIFA (2011)

		vertikale Beleuchtungsstärke			horizontale Beleuchtungsstärke			Eigenschaften der Lampen	
		Ev cam ave	Gleichmäßigkeit		Eh ave	Gleichmäßigkeit		Farbtemperatur	Farbwiedergabe
Klasse	Berechnung für	Lux	U1	U2	Lux	U1	U2	Tk	Ra
Klasse V international	Festkamera	> 2000	0,6	0,7	3500	0,6	0,8	> 4000	≥ 65
	Spielfeldkamera (auf Feldhöhe)	1800	0,4	0,65					
Klasse IV national	Festkamera	2000	0,5	0,65	2500	0,6	0,8	> 4000	≥ 65
	Spielfeldkamera (auf Feldhöhe)	1400	0,35	0,6					

Ra

≥ 65

Source: https://resources.fifa.com/mm/document/tournament/competition/51/54/11/stadium_tech_rec_req_guide_to_lighting_en_7306.pdf

New FIFA Stadium Requirements - World Cup Russia

The color rendering index of the lamps used should be equal to or greater than Ra 90. For Level V events it is especially important that the colors are faithfully reproduced.

It is especially important to ensure that the red and blue values are displayed to produce vivid television images.

2018 FIFA World Cup Russia™ Stadium Requirements Handbook

25.30.20 – Floodlight

subject to changes by

Colour Rendering

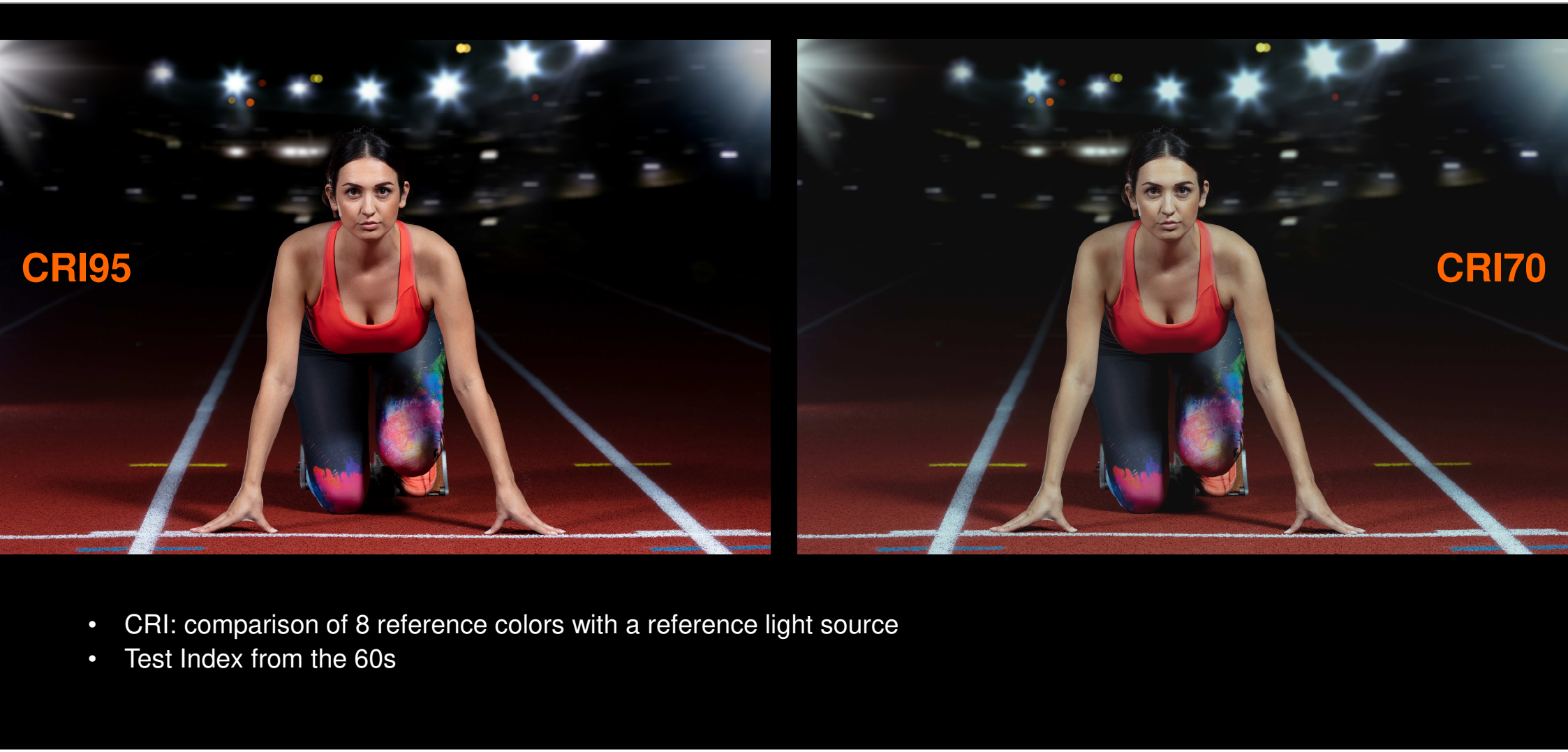
The colour rendering index of the lamps used shall be equal to or greater than Ra 90. For level V events it is particularly important that scene colours are faithfully reproduced. It is particularly important to ensure that red and blue levels are maintained in order to produce vivid broadcast images

Horizontal illuminance (Eh) ; Vertical / camera (Ev / Ecam) = 1.5≤2:1

Summary of Lighting Specifications for Televised Events

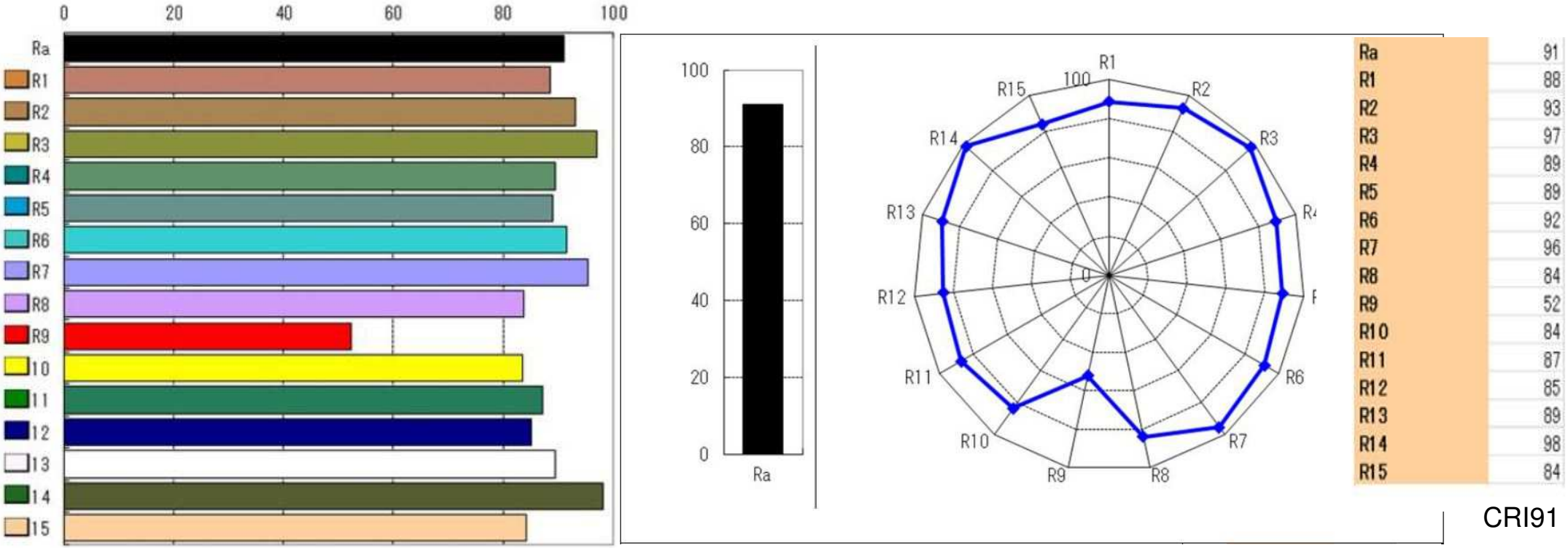
		Vertical Illuminance			Horizontal Illuminance			Properties of Lamps	
		Ev cam average	Uniformity		Eh average	Uniformity		Nominal colour temperature	Colour rendering
Class	Calculation towards	Lux	U1	U2	Lux	U1	U2	Tk	Ra
Class V International	Fixed cameras	>2,000	0.6	0.7	Eh:Ev ≤2:1	0.7	0.8	≥4,000 ≤6500K	≥90
	Field cameras	>1,800	0.6	0.7					
	Orthogonal Vertical	NA	0.5	0.7					

Colour Rendering Index (CRI)
Standard of the International Lighting Commission (CIE)



- CRI: comparison of 8 reference colors with a reference light source
- Test Index from the 60s

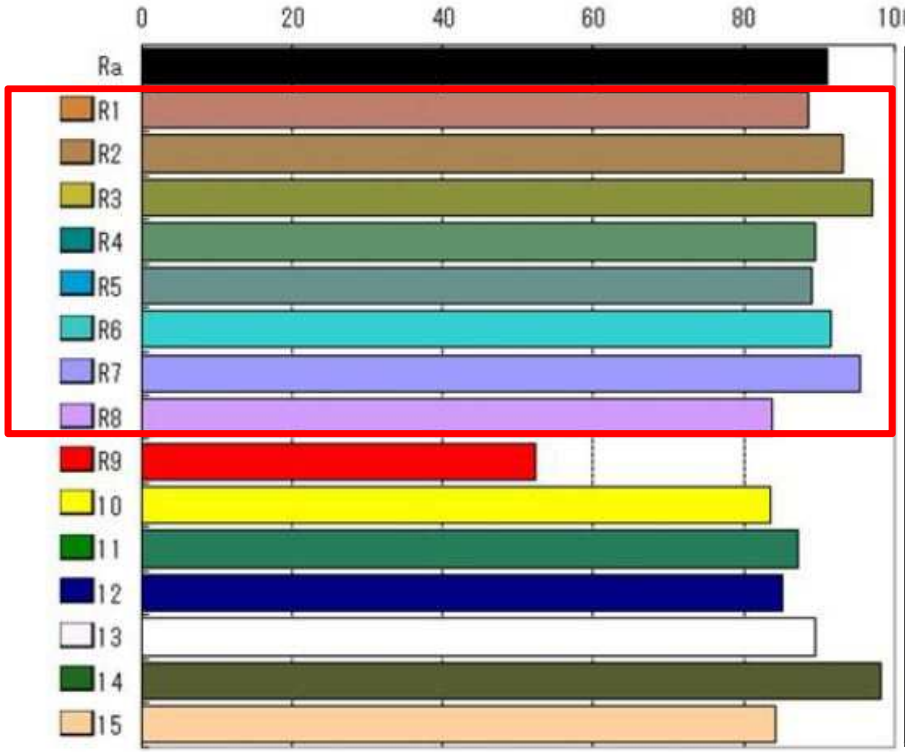
CRI Requirements – UEFA Lighting Guide 2016

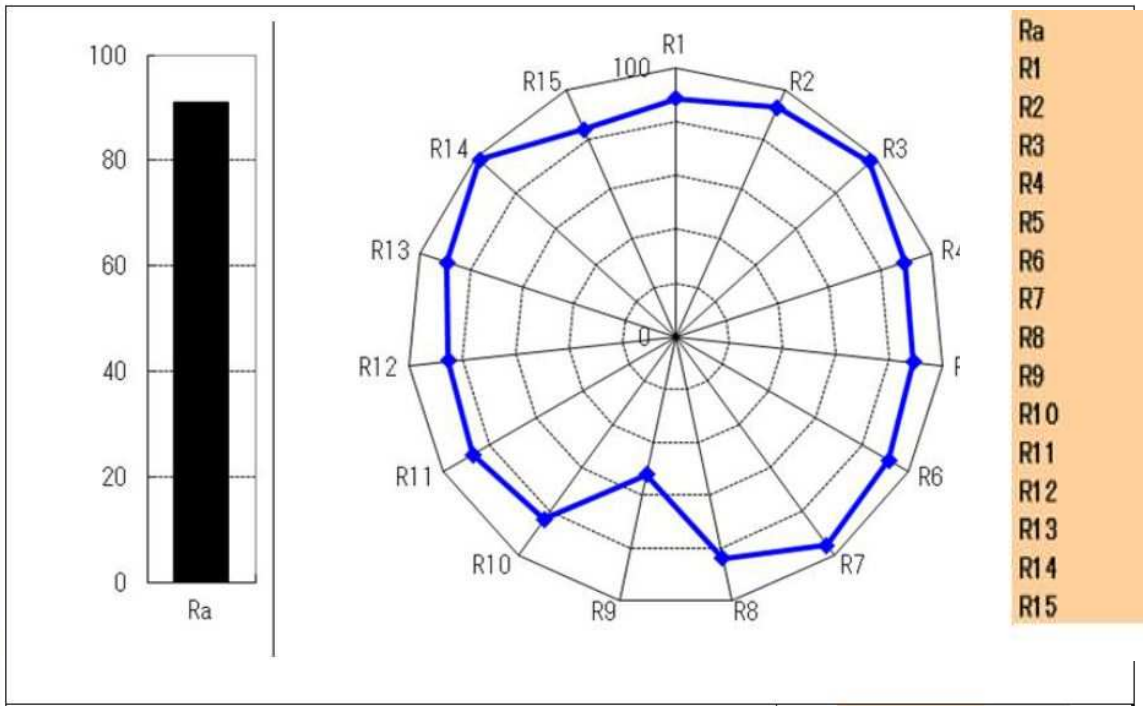


CRI91

Quelle: UEFA Lighting Guide 2016

CRI Requirements– UEFA Lighting Guide 2016





Ra	91
R1	88
R2	93
R3	97
R4	89
R5	89
R6	92
R7	96
R8	84
R9	52
R10	84
R11	87
R12	85
R13	89
R14	98
R15	84

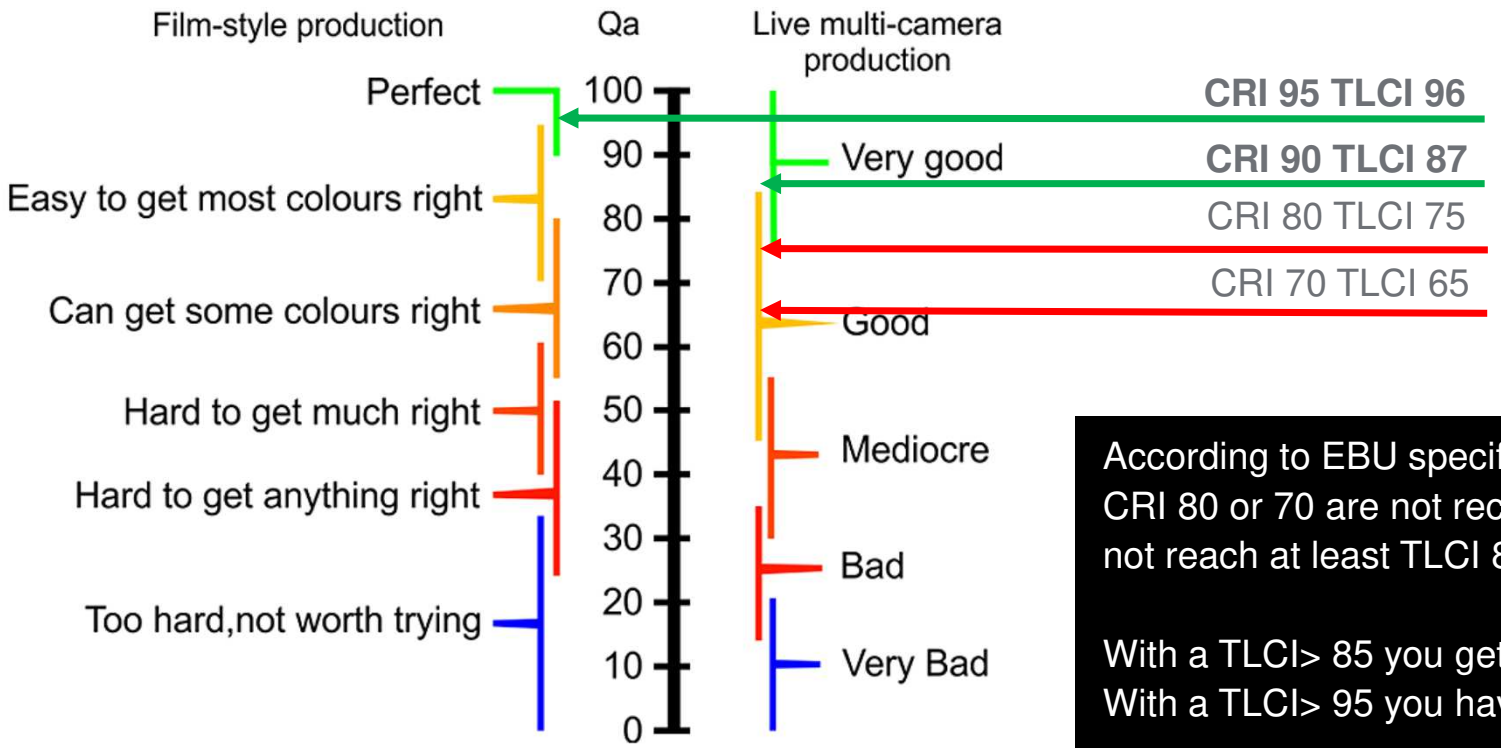
CRI91

Perfect Picture

Television Lighting Consistency Index (TLCI)

- Recommendation EBU
  (European Broadcasting Union)
- TLCI - 2012
  The ability of the floodlight to reproduce colors as naturally as possible and correctly
- Comparison with 18 reference colors along the spectrum of a reference light source
- Special Broadcasting requirements:
  Values between 85 and 100 do not require a correction for the camera equipment

Television Lighting Consistency Index (TLCI)



According to EBU specifications lights with a CRI 80 or 70 are not recommended, since you can not reach at least TLCI 85.

With a TLCI> 85 you get TV standard
With a TLCI> 95 you have the CINEMA standard

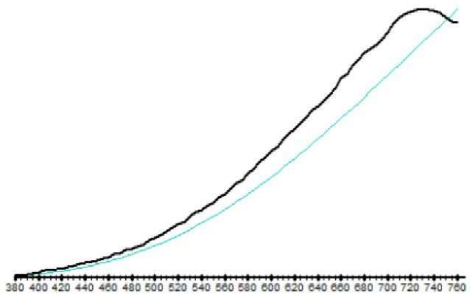
Quelle: TELEVISION LIGHTING CONSISTENCY INDEX-2012 AND TELEVISION LUMINAIRE MATCHING FACTOR-2013

Television Lighting Consistency Index (TLCI)

Quelle: TELEVISION LIGHTING CONSISTENCY INDEX-2012 AND TELEVISION LUMINAIRE MATCHING FACTOR-2013

Television Lighting Consistency Index-2012

Sector	Lightness	Chroma	Hue
R	0	0	0
R/Y	0	0	0
Y	0	0	0
Y/G	0	0	0
G	0	0	0
G/C	0	0	0
C	0	0	0
C/B	0	0	0
B	0	0	0
B/M	0	0	0
M	0	0	0
M/R	0	0	0



CRI: 100
TLCI:100

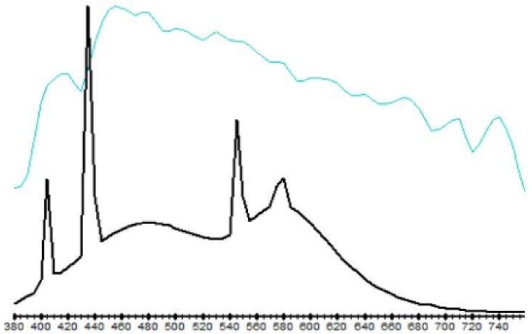
R = Red
Y = Yellow
G = Green
C = Cyan
B = Blue
M = Magenta

Television Lighting Consistency Index (TLCI)

Quelle: TELEVISION LIGHTING CONSISTENCY INDEX-2012 AND TELEVISION LUMINAIRE MATCHING FACTOR-2013

Television Lighting Consistency Index-2012

Sector	Lightness	Chroma	Hue
R	+++++++	+++	+
R/Y	0	+	- - -
Y	0	-	- -
Y/G	0	-	0
G	-	0	++
G/C	0	0	+
C	0	+	0
C/B	++	0	- - -
B	+	-	0
B/M	++	-	+++++++
M	++++	0	+++++++
M/R	+++++++	0	+++++++



CRI: 50 - 90

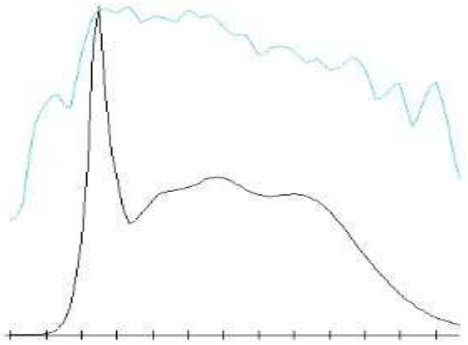
R = Red
Y = Yellow
G = Green
C = Cyan
B = Blue
M = Magenta

Television Lighting Consistency Index (TLCI)

Quelle: Test Siteco VDE Certified Laboratory

Television Lighting Consistency Index-2012

	Helligkeit	Sättigung	Farbton
Sector	Lightness	Chroma	Hue
R	0	0	0
R/Y	0	0	-
Y	0	0	0
Y/G	0	0	0
G	0	0	0
G/C	0	0	0
C	0	0	0
C/B	0	0	--
B	0	-	-
B/M	0	0	0
M	0	0	0
M/R	0	0	0



CRI: 95
TLCI:96

R = Red
Y = Yellow
G = Green
C = Cyan
B = Blue
M = Magenta


CINEMA Standard

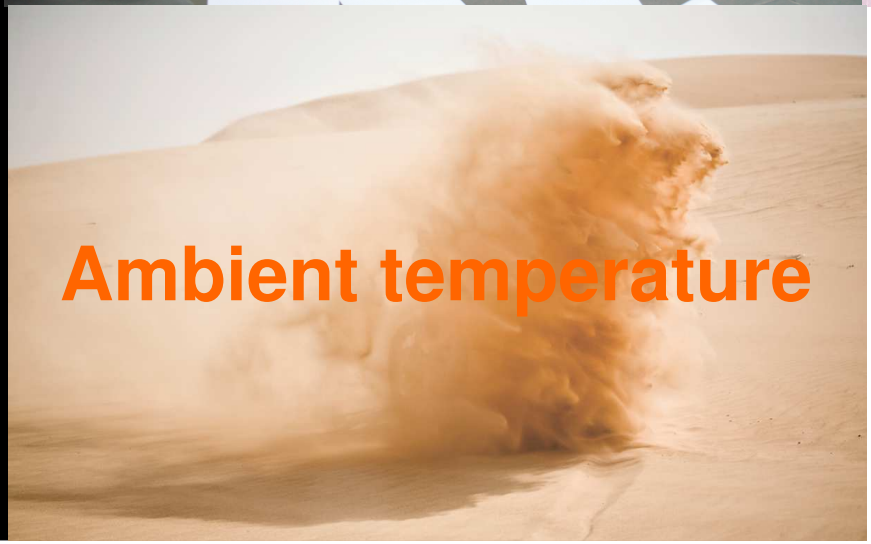
Dynamic Temperature Control

CLO 2.0

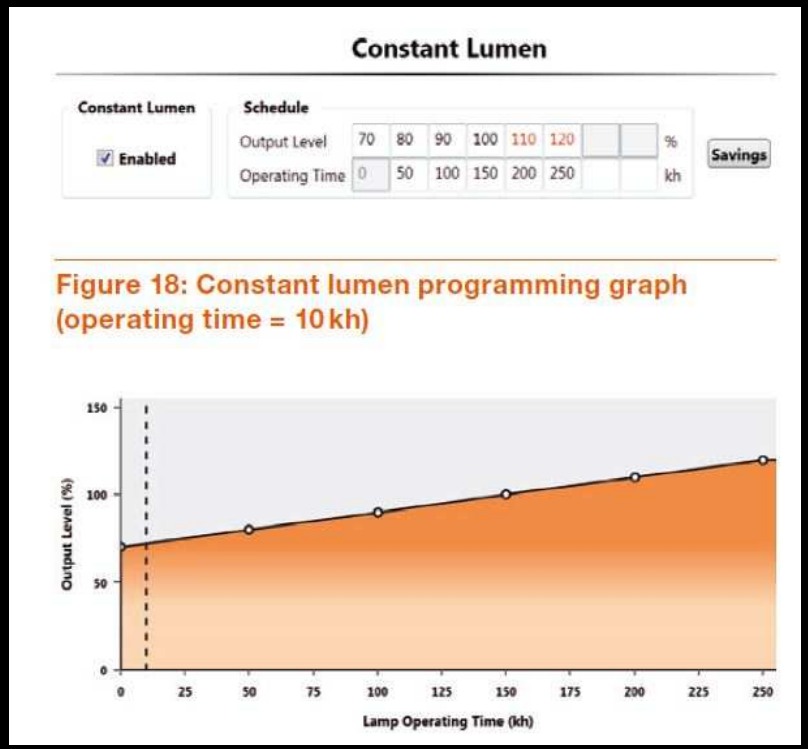
Is my calculation with Constant-Lumen-Output correct?

LED - Temperature

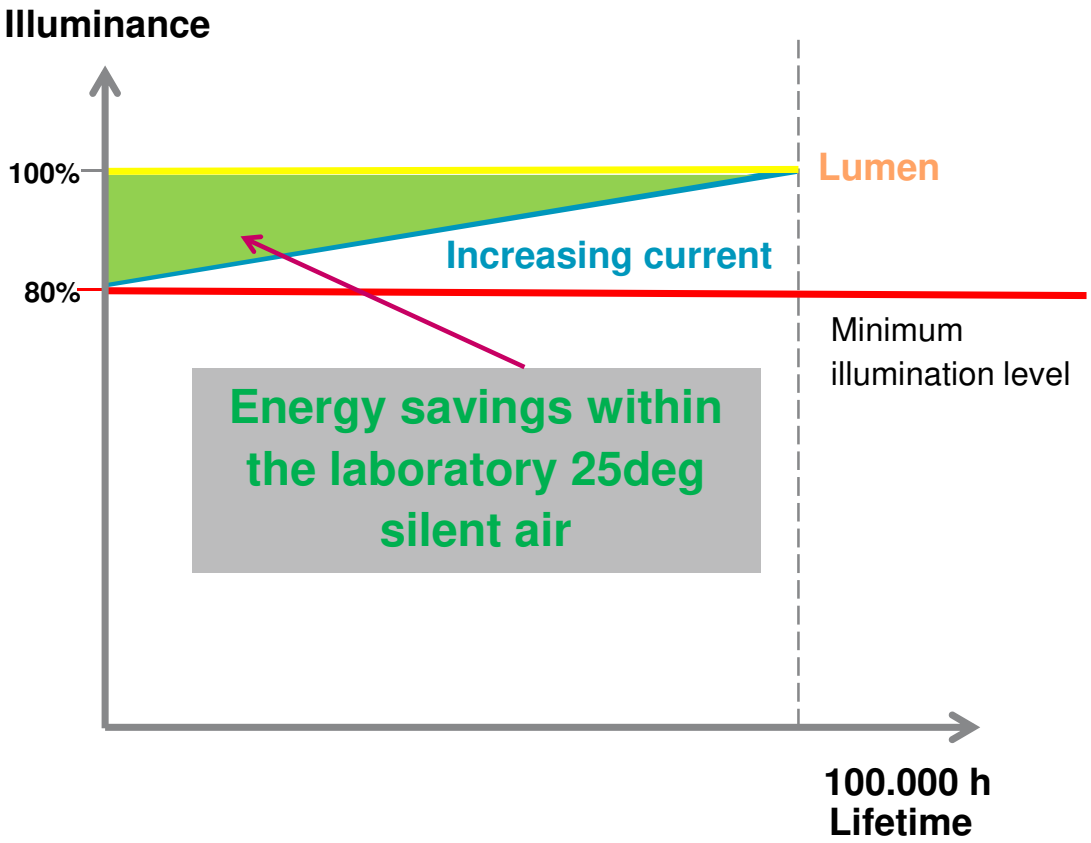
Decrease the temperature of the LEDs, the LEDs become more efficient and give a higher luminous flux.
The LEDs can be dimmed. So you can keep the luminous flux constant!



CLO - Constant Lumen Output (CLO)



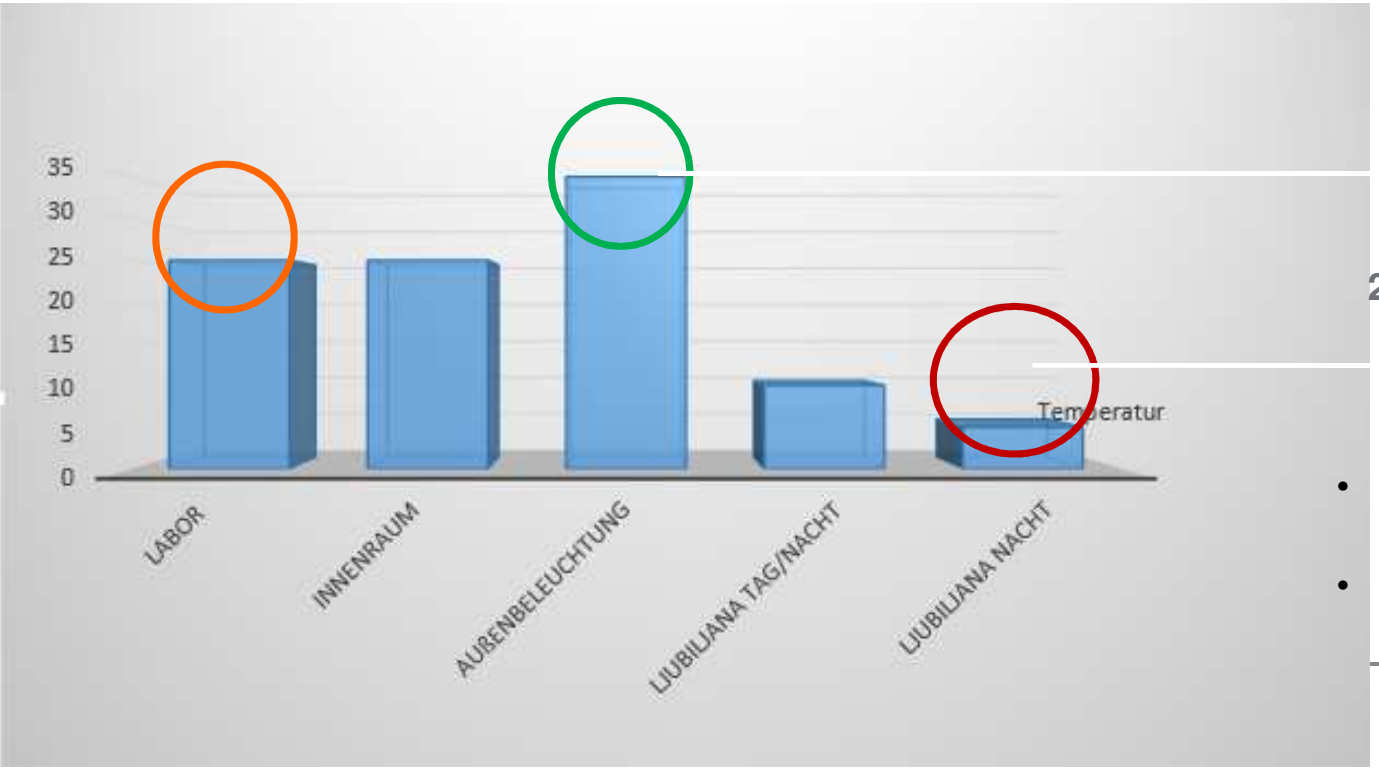
Quelle: Technical application guide
4DIMLT2 LED drivers



Temperature evaluation of floodlights acc. IEC60598-1

5.12 Testing of durability and warming

5.12.1 On the basis of the limit values according to IEC 60598-1, section 12, floodlights must be used for outdoor use, subtracted from the 10 ° C measured in the test room in order to take into account the effects of natural air movement occurring in practice.



28° C

Lum

Lab
Planning

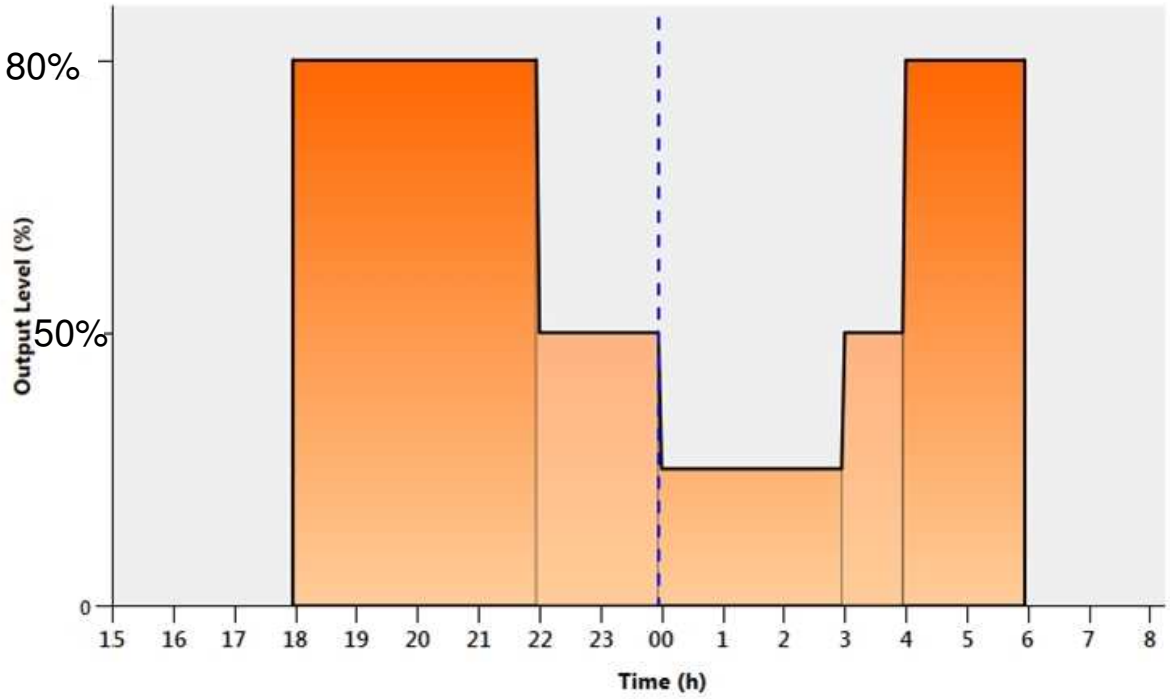
Reality

- **Average annual temperature Abu Dhabi Night 25 ° C**
- **LED power fluctuations Winter/Summer between 3% and 6%**

siteco traxon ecue OSRAM

Astrodim – Astro based power reduction

- **Default CLO Start 80%**
- **Energy savings (Example 33%)**
- **Power increase due to lower LED temperature ~ 5%**



CLO – Control – no temperature control

CLO

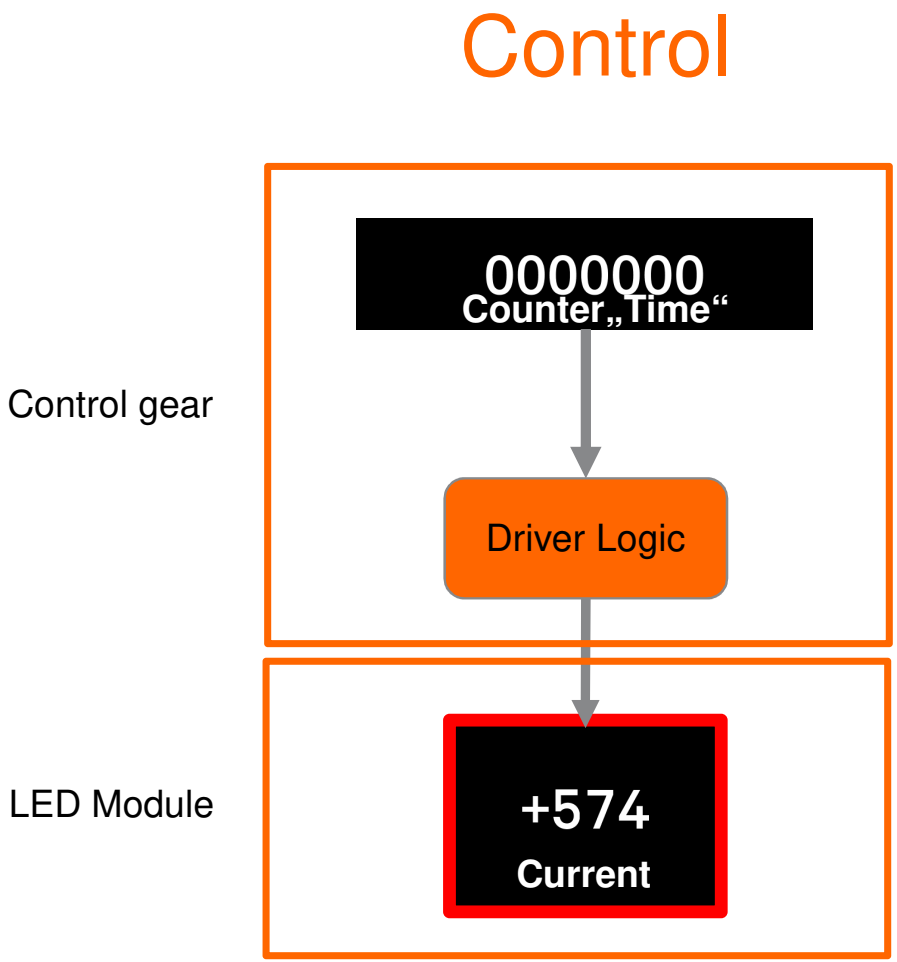
- Energyzing characteristics is set to 25°C laboratory conditions (standing air)
- Linear current increase – no year or daily adaptations

Advantage

- No demand for a special intelligence of the driver in order to work with specific LED modules

Disadvantage

- Too high current
- No temperature control– only overheating protection
- ***Faster end of life → LED modules***

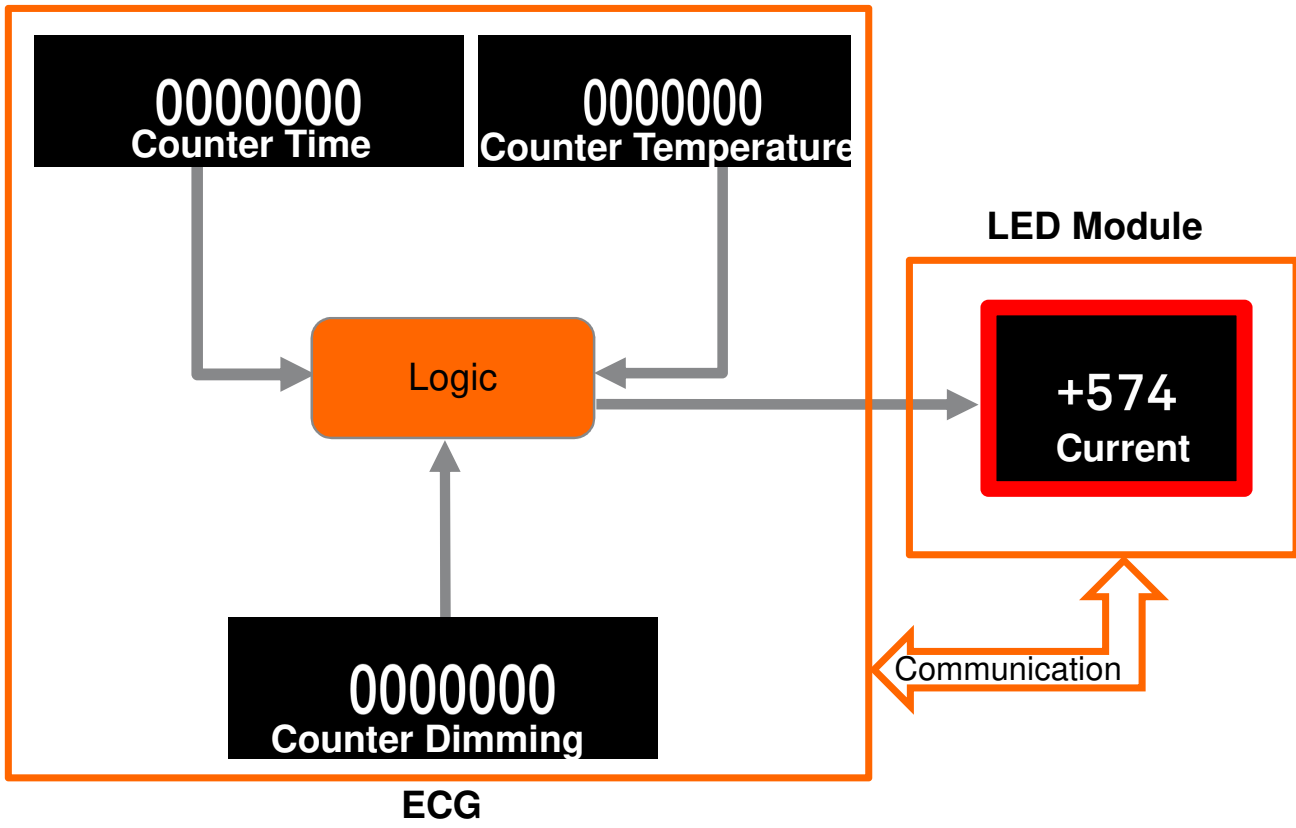


CLO 2.0 – Control – Temperature Control

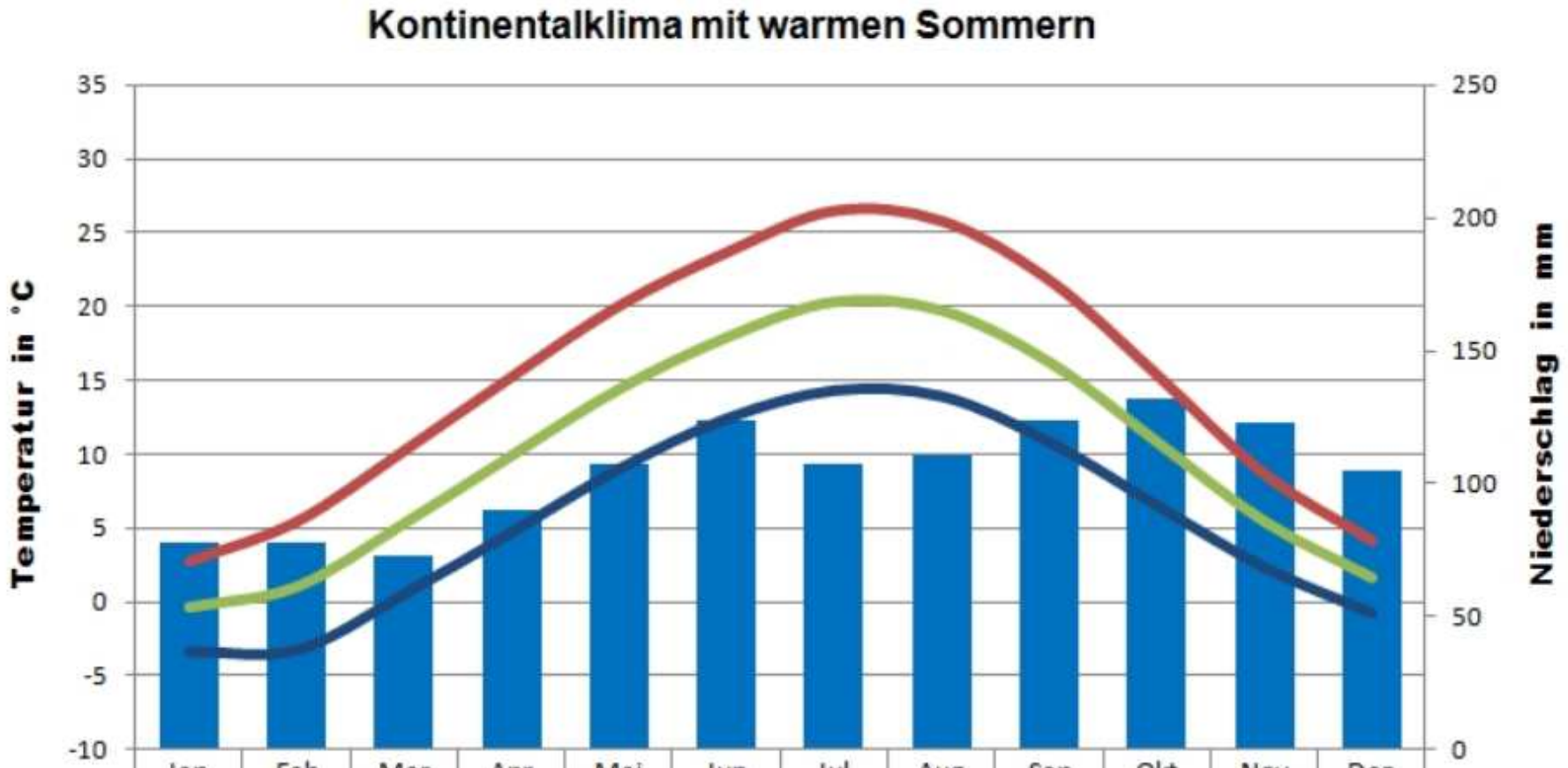
- Individual current depending on the outdoor temperature
- Individual current depending on the operation time / dimming of the LED module
- Individual current depending on the LED type LED Typ

Advantage CLO 2.0

- Maximum of power and lifetime concerning the LED components
- Constant luminous flux due to individual current

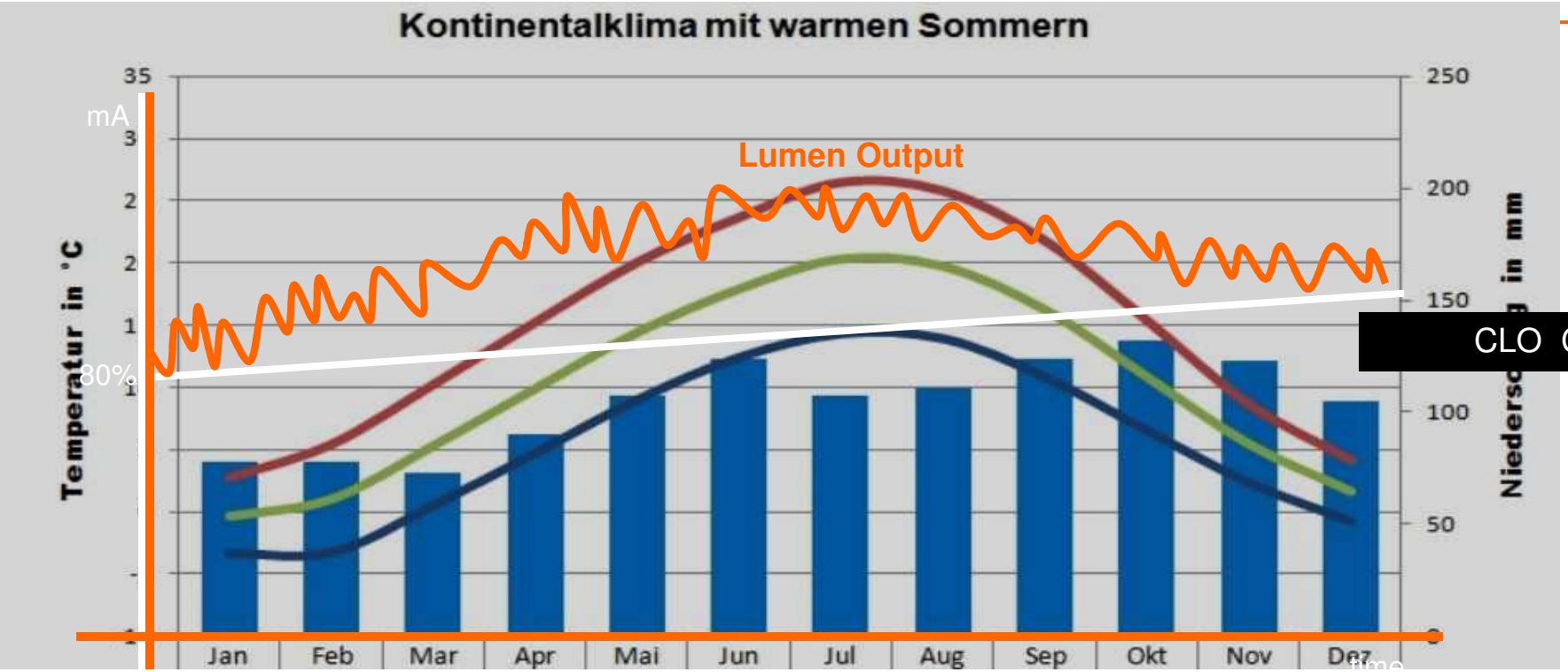


CLO 2.0 - Average annual temperature Ljubiljana



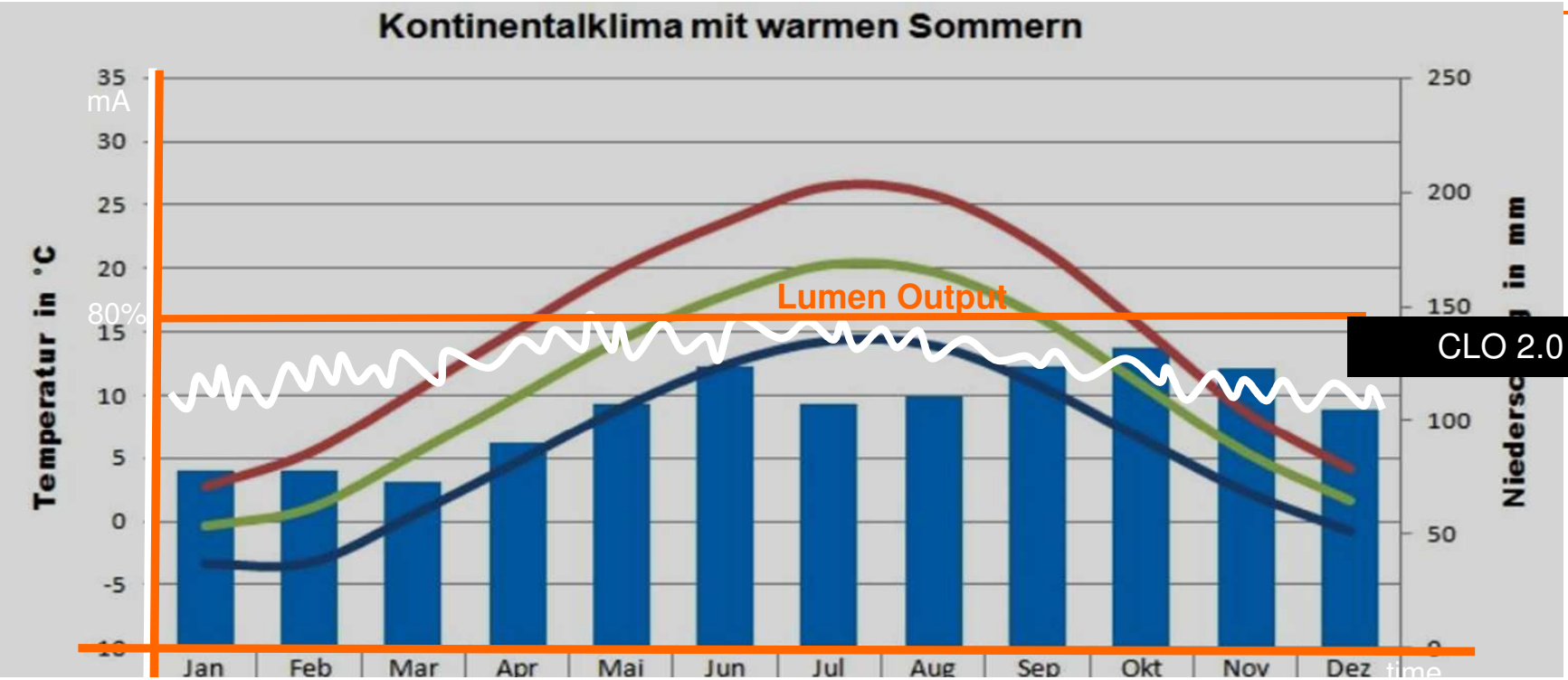
	Jan	Feb	Mar	Apr	Mai	Jun	Jul	Aug	Sep	Okt	Nov	Dez
Niederschlag in mm	78	78	73	90	107	124	107	111	124	132	123	105
Höchsttemperatur	2,8	5,5	10,3	15,3	20,1	23,7	26,5	25,8	21,8	15,4	8,7	4,2
Mitteltemperatur	-0,3	1,1	5,4	10,0	14,5	18,0	20,4	19,8	16,3	10,9	5,5	1,7
Tiefsttemperatur	-3,4	-3,3	0,5	4,7	9,0	12,4	14,3	13,9	10,8	6,5	2,3	-0,8

CLO – linear current



The current supply with CLO setting causes the LED to reach its end of life earlier than necessary.
The deviation may amount to 10% (incl. Astrodim) in Western Europe.

CLO 2.0 – individual current



With a CLO 2.0 control you can fully exploit the performance of the light. Regardless of the location of the luminaire, always the right current supply. Greenland or Sicily. **The luminaire controls itself!**

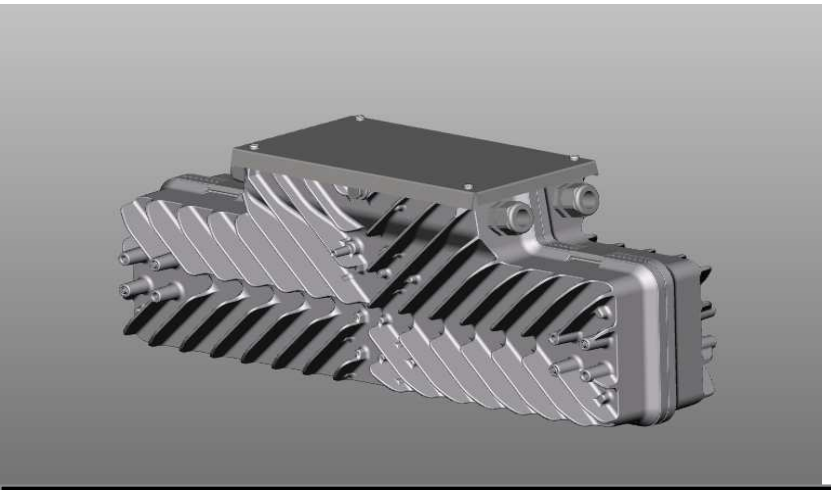
Benefit of CLO 2.0

Advantage

- Constant luminous flux independent from the outdoor temperature / Wind / Rain / Snow
- Longer lifetime of LED Module and electronical components (less thermal stress)
- Lower energy consumption
- Constant luminous flux independent of the luminaire's age
- Higher maintenance factor → less floodlights

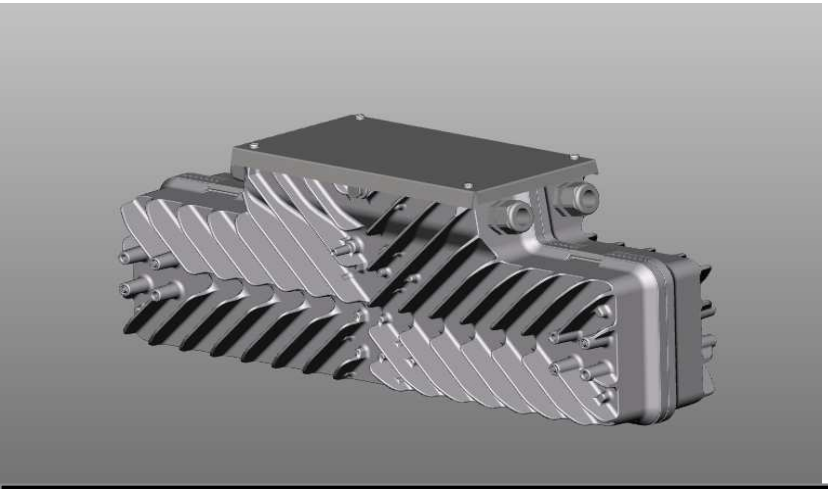
Maintenance
ONE WIRE

Maintenance – ONE WIRE



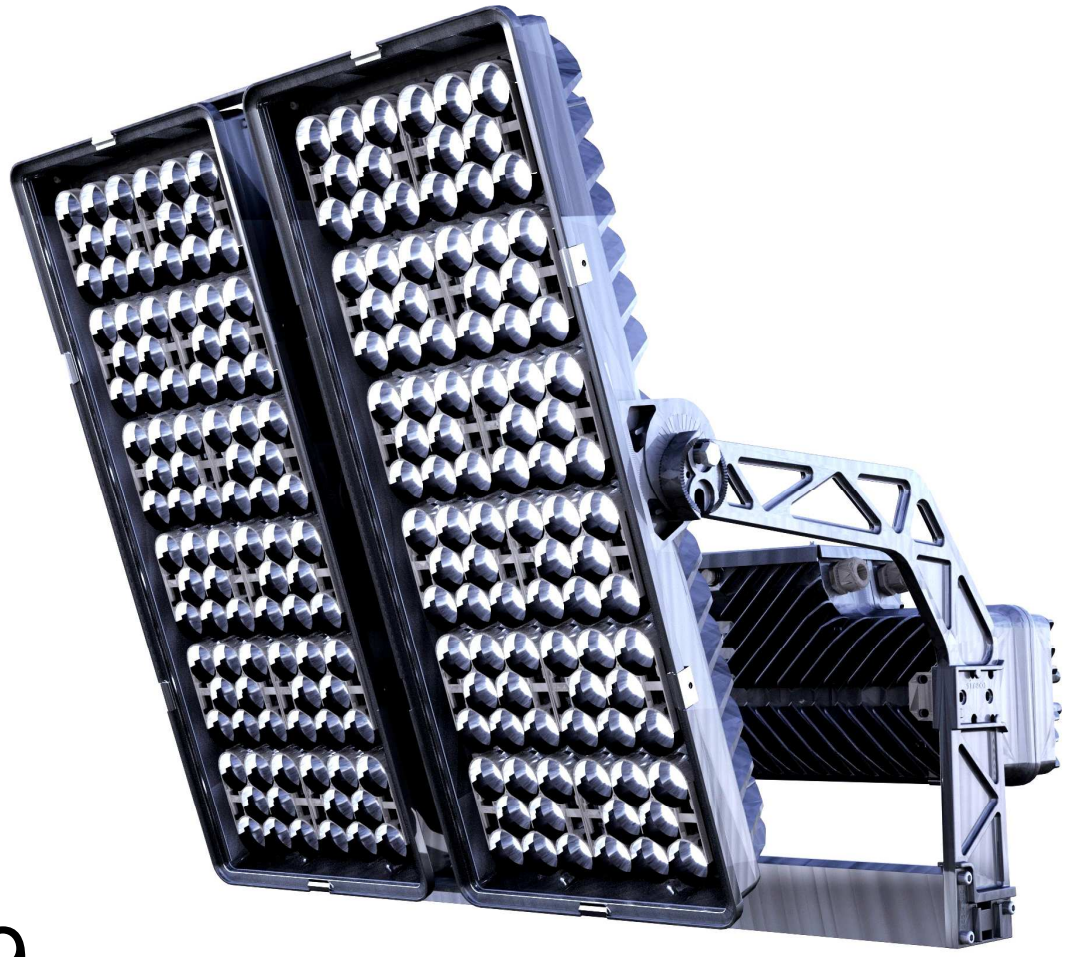
- **Exchange Current Information**
- **Exchange Lifetime**
- **Exchange Component Spec.**
- **Exchange Temperature Chart**

Maintenance – ONE WIRE



- **Exchange Current Information**
- **Exchange Lifetime**
- **Exchange Component Spec.**
- **Exchange Temperature Chart**

- **Ease Spare Part Management**
- **Future proof system**



SIRIUS

January 2019

Many thanks for your attention!

siteco traxon ecue

OSRAM