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Dam-Hansen, Carsten

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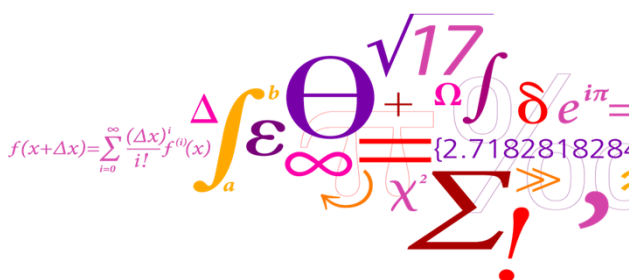
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Test og karakteristik af LED-lyskilder og lamper

Carsten Dam-Hansen, DTU Fotonik



DTU Fotonik
Department of Photonics Engineering


DTU Fotonik
Department of Photonics Engineering



Indhold


- LED og SSL status, hvorfor er test nødvendigt?
- Ny LED test standard
- Virker den nye standard?
 - International laboratorie sammenligning
- Quality lab, forsknings og kommercielt fotometri
 - Integreerede kugle faciliteter
 - Goniofotometer facilitet
- Levetid: lumen og color maintenance
- Laboratorie rundvisning

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Status, LED enheder

LED enheder

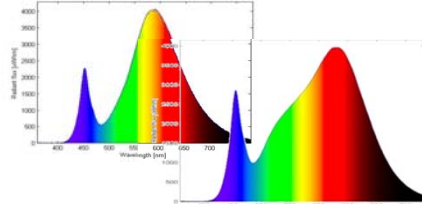



3 mm
(~ 1-5 W, ~400 lm)

Farvetemperatur

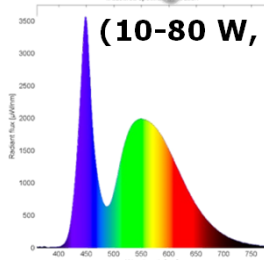
2200 - 3500 K > 5000 K

Effektivitet:
123 lm @ 350 mA ~ 117 lm/W





(10-80 W, 1500-6000 lm)




160 lm @ 350 mA ~ 152 lm/W (@ 25 °C)
139 lm @ 350 mA ~ 132 lm/W (@ 85 °C)

Laboratorie resultater: 303 lm/W

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Status, SSL produkter

SSL produkter er baseret på LED enheder
inkluderer optik, køleprofil og elektronik


Retrofit produkter

60-120 lm/W



LED armaturer


~ 90-130 lm/W



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International/europæisk Test Standard

Der er en international og en europæisk test standard for SSL produkter udgivet i år og udarbejdet i samarbejde imellem:


CIE TC2-71, Chair, Yoshi Ohno (US)
CEN TC169 WG7, Chair, Guy Vandermeersch (BE)

CIE S 025/E:2015 Test Method for LED Lamps, LED Luminaires and LED Modules

EN 13032 Lighting Applications — Measurement and presentation of photometric data of lamps and luminaires — Part 4: LED lamps, modules and luminaires

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International/europæisk Test Standard

Absolut fotometri, lamper og armaturer måles i forhold til en kalibreret standard lamp (halogen)

Test procedure,


- Ingen indbrænding
- Termisk stabilisering 0.5 % variation i lysstrøm og effekt
- Omgivelses temperatur 25°C ± 1.2°C
- Integrerende kugle (2π og 4π setup) med spektroradiometer, eller med fotometer
- Goniofotometer med fotometer og/or spektroradiometer





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International/europæisk Test Standard


	Acceptance interval* ¹ (WD2)	Instrument uncertainty (k=2) (WD2)	Tolerance Interval* ² (WD3)
Ambient temperature	± 1 °C	≤ 0.2 °C	± 1.2 °C
Surface temperature (LED module)	± 2 °C	≤ 0.5 °C	± 2.5 °C
Air movemet speed	± 0.2 m/s	≤ 0.05 m/s	± 0.25 m/s
Supply voltage (AC)	± 0.2 %	≤ 0.2 %	± 0.4 %
(DC)	± 0.1 %	≤ 0.1 %	± 0.2 %

*¹ called "tolerance interval" in WD2
 *² no requirement of instrument uncertainty in WD3

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International/europæisk Test Standard Parametre

Fotometrisk:



- Luminous flux [lm]
- Partial Luminous flux [lm]
- Efficacy [lm/W]
- Luminous intensity distribution [cd]

Electrisk:

- Power [W]
- Current [A]
- Power factor

Kolorimetrisk:


- Correlated color temperature [K], Duv
- Color rendering index
- Color coordinates

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Usikkerhed

Resultatet af målinger skal angives med usikkerhed (evt. for produkt type)

$\Phi = 834 \text{ lm} \pm 4 \%$

CCT = 3120 K \pm 61 K	x = 0.3543 \pm 0.0035
CCT = 6540 K \pm 255 K	y = 0.5443 \pm 0.0050


Udvidet usikkerhed k=2 svarende til at den rigtige værdi med 95 % sikkerhed ligger indenfor det angivne interval

Total flux vil således være i intervallet: [801 lm – 867 lm]

Det er svært for testlaboratorier at udføre usikkerhedsberegninger, især for kolorimetriske parametre. Teknisk note fra CIE er under udarbejdelse.

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IC2013 world's largest interlaboratory comparison on SSL

- **Undersøge robusthed af SSL test metode igennem international laboratory comparison (IC2013)**
- **Midlertidig SSL test metode der benytter de strengeste krav og tolerancer således at alle opfyldes:**
 - LM-79-08 IESNA
 - CEN/CIE Test method draft
 - IEC 62722 (LED luminaire) IEC 62612 (LED lamp) Annex A
 - JIS 7801, 8105-5 (Japan)
- **5-6 forskellige typer af LED lamps**
- **Måle Protokol**
- **PPR og IR er givet til deltagende laboratorier**
- **Som færdighedstest ISO/IEC 17043**
- **Slutrapport er udgivet i går <http://ssl.iea-4e.org/>**
- **Generelt god overensstemmelse flux \pm 4 %, kromaticitet \pm 0.004**
- **Vist at metoden er god undtagen for strømmålinger**

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IC2013 world's largest interlaboratory comparison on SSL

23 laboratorier har gennemført IC2013 i Europa under VSL, I Danmark har DTU Fotonik og Delta deltaget.

	Country	Laboratories	Nucleus Lab
Europe	FRANCE	6	VSL
	Netherlands	4	VSL
	Sweden	3	VSL/NLTC
	Denmark	2	VSL
	Germany	2	VSL
	United Kingdom	2	VSL
	Belgium	1	VSL
	Finland	1	VSL
	Russia	1	VSL
	Asia/Pacific	Japan	12
China		5	NLTC
Korea		5	VSL
Taiwan		4	NLTC
Australia		3	NLTC
New Zealand		1	NLTC
Americas		Canada	1
	Brazil	1	NIST
Total		54	

Nucleus Lab	laboratories
AIST, NMIJ	12
NIST	2
NLTC	14
VSL	26
Total	54

NIST MAP NVLAP linked labs	45
APLAC PT linked labs	21
Grand total	110

Nucleus Labs	4
Total number of labs	114
Repeated testing	3
Total number of data entry For final report	123

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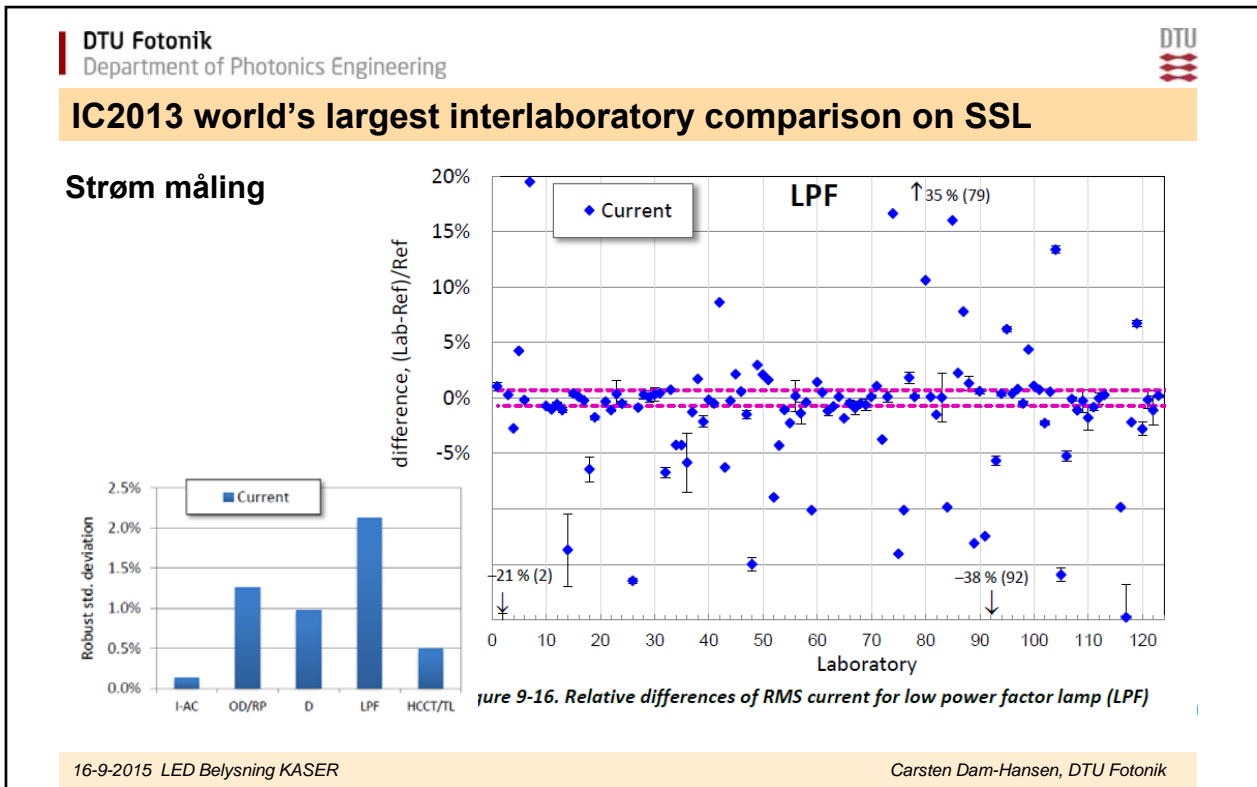
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Lysstrøm måling

9-2. Relative differences of total luminous flux for omnidirectional LED lamp (OD)

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Integrating sphere lab

Total spektral flux målinger i total flux (4π) og i forward flux (2π) konfiguration:

1m og 2m diameter kugler, med 15 og 60 cm port

Til måling af

- Total spectral power distribution
- Luminous flux [lm]
- Efficiency [lm/W]
- Correlated Color temperature, Duv
- Color rendering index, other color rendering metrics

Bølgelængde område:
 Array spektrometer, 360-830 nm
 Dobbelt monokromator, 250-1700 nm, (UV og blue light hazard)

LED komponenter under strøm og temperatur kontrol

The photograph shows a large black integrating sphere with a circular opening. A smaller blue sphere is visible in the background. A spectral power distribution graph is overlaid on the bottom right, showing relative intensity vs wavelength (nm) from 400 to 700 nm.

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Goniofotometer lab

Nærfelts goniofotometer
Lamper med 2m i største dimension

måling af vinkel fordeling af

- Intensitet (LID),
ies-file eller eulumdat file, Ray data
- Kromaticitet
- Spectral power distribution,
- Correlated Color temperature, Duv
- Color rendering index

og

- Lysstrøm [lm]
- Effekt [W]
- Effektivitet [lm/W]

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Luminous flux maintenance

LED fejler ikke pludseligt, men degraderer langsomt – også efter at have nået brugbar lysstrøm


Langtids målinger af lumen maintenance (48 retrofit LED lamps over 20.000 h)

Etableret IES standard for LED packages: LM-80 and TM-21
Ny IES standards for LED lamps: LM-84-14 and TM-28-14
Behov for accelerated test methods, med on/off cycling

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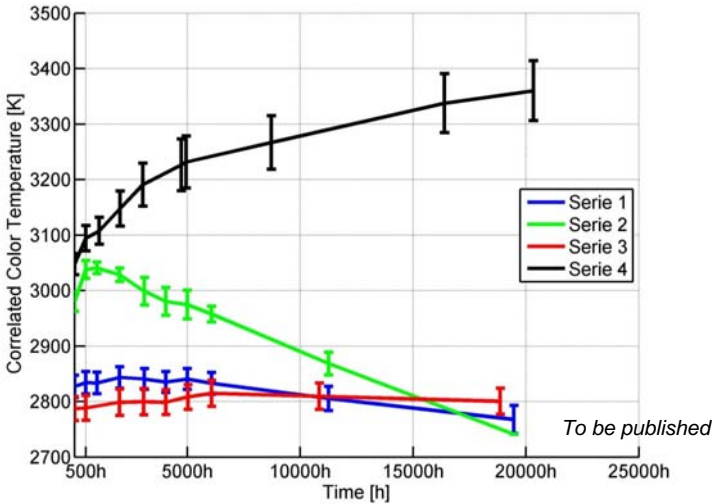
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Color maintenance

Correlated color temperature som funktion af tid:






Time [h]	Serie 1 [K]	Serie 2 [K]	Serie 3 [K]	Serie 4 [K]
500h	2830	3050	2790	3100
5000h	2830	2980	2800	3220
10000h	2810	2880	2800	3280
15000h	2800	2800	2800	3320
20000h	2780	2750	2800	3350

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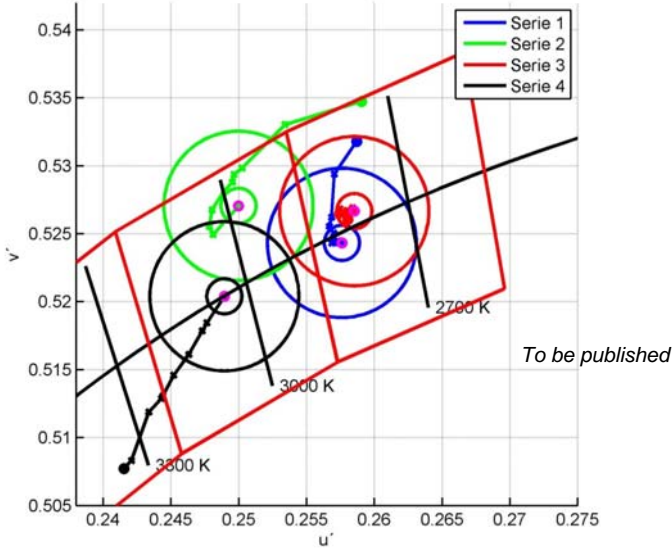
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Color maintenance

Farve skift selvom CCT er konstant, chromaticity coordinates som funktion af tid:





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Tak for opmærksomheden

I laboratoriet får I mulighed for at se og stille flere spørgsmål

Eller kan jeg kontaktes på

cadh@fotonik.dtu.dk