



## Test og karakteristik af LED-lyskilder og lamper

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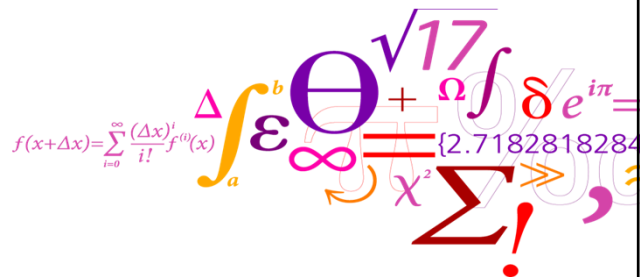
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# Test og karakteristik af LED-lyskilder og lamper

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## 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**



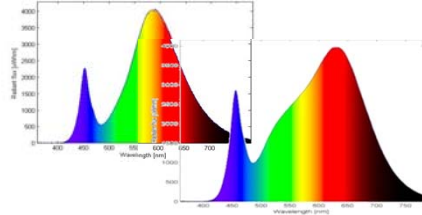
3 mm  
(~ 1-5 W, ~400 lm)

**Farvetemperatur**

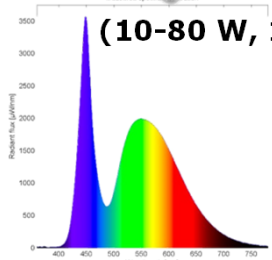


2200 - 3500 K > 5000 K

**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* <sup>1</sup> (WD2)	Instrument uncertainty (k=2) (WD2)	Tolerance Interval* <sup>2</sup> (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 %

\*<sup>1</sup> called "tolerance interval" in WD2  
 \*<sup>2</sup> 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
	Aasia/Pacific	Japan	12
	China	5	NLTC
	Korea	5	VSL
	Taiwan	4	NLTC
	Australia	3	NLTC
	New Zealand	1	NLTC
Americas	Canada	1	NIST
	Brazil	1	NIST
	<b>Total</b>	<b>54</b>	

Nucleus Lab	laboratories
AIST, NMIJ	12
NIST	2
NLTC	14
VSL	26
<b>Total</b>	<b>54</b>

NIST MAP NVLAP linked labs	45
APLAC PT linked labs	21
<b>Grand total</b>	<b>110</b>

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

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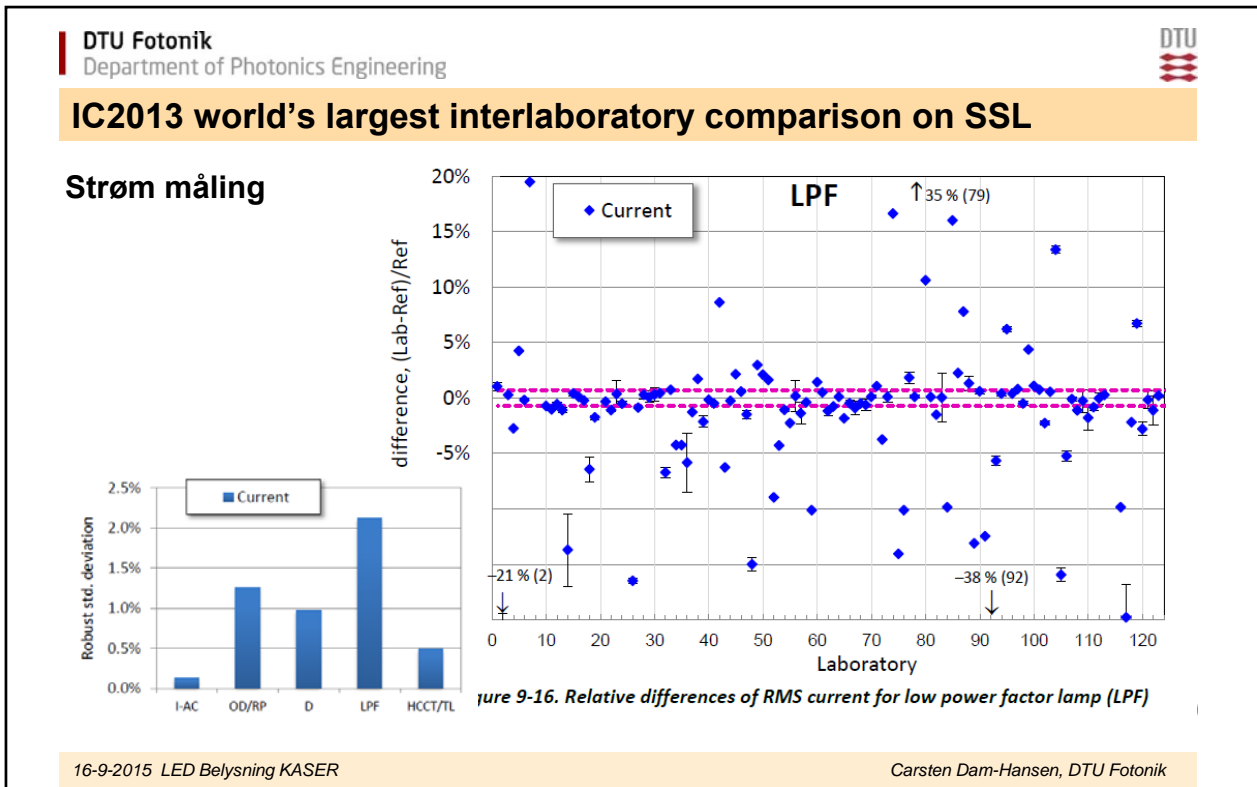
**IC2013 world's largest interlaboratory comparison on SSL**

**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 ( $4\pi$ ) og i forward flux ( $2\pi$ ) 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

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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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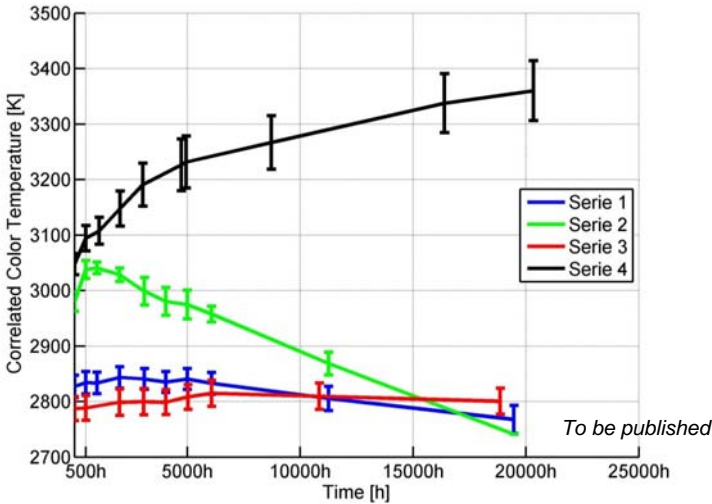
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## Color maintenance

**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

*To be published*


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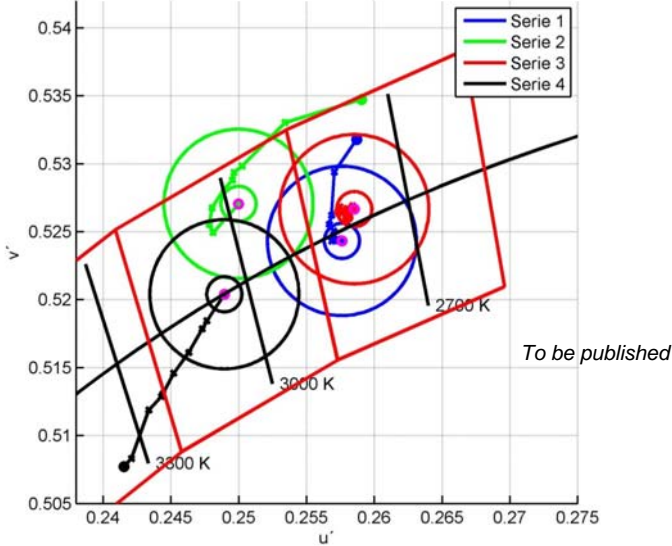
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## Color maintenance

**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](mailto:cadh@fotonik.dtu.dk)**