



# Relighting LED

## *Technology reconnaissance for a test case*

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16 March 2015

*Laboratory Light*

*Belgian Building Research Institute*

# Context

## BBRI

- Old Building – End of '60s





# Luminaires 60x60

## Existing situation

- Old luminaires in the ceiling
- Modular ceiling – low height



Luminaires with T5 lamps



Luminaires with T8 lamps

Light Output Ratio ~ 60%  
Energy efficiency : 47 lm/W



Luminaires with T8 lamps  
and diffuser

# Retrofitting with luminaires 60x60

## Led Solutions – Energy efficiency

Set of 6 ‘new’ products with leds

Energy efficiency led *modules* (04/2014): 120 - 150 lm/W

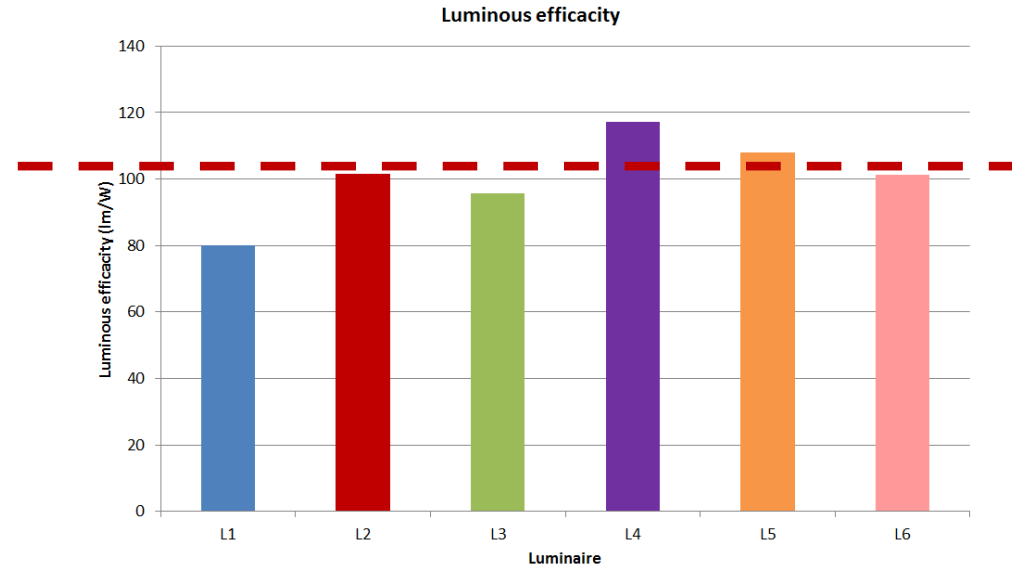
Energy efficiency *luminaires* (04/2014):

(with optical elements, drivers, etc....)

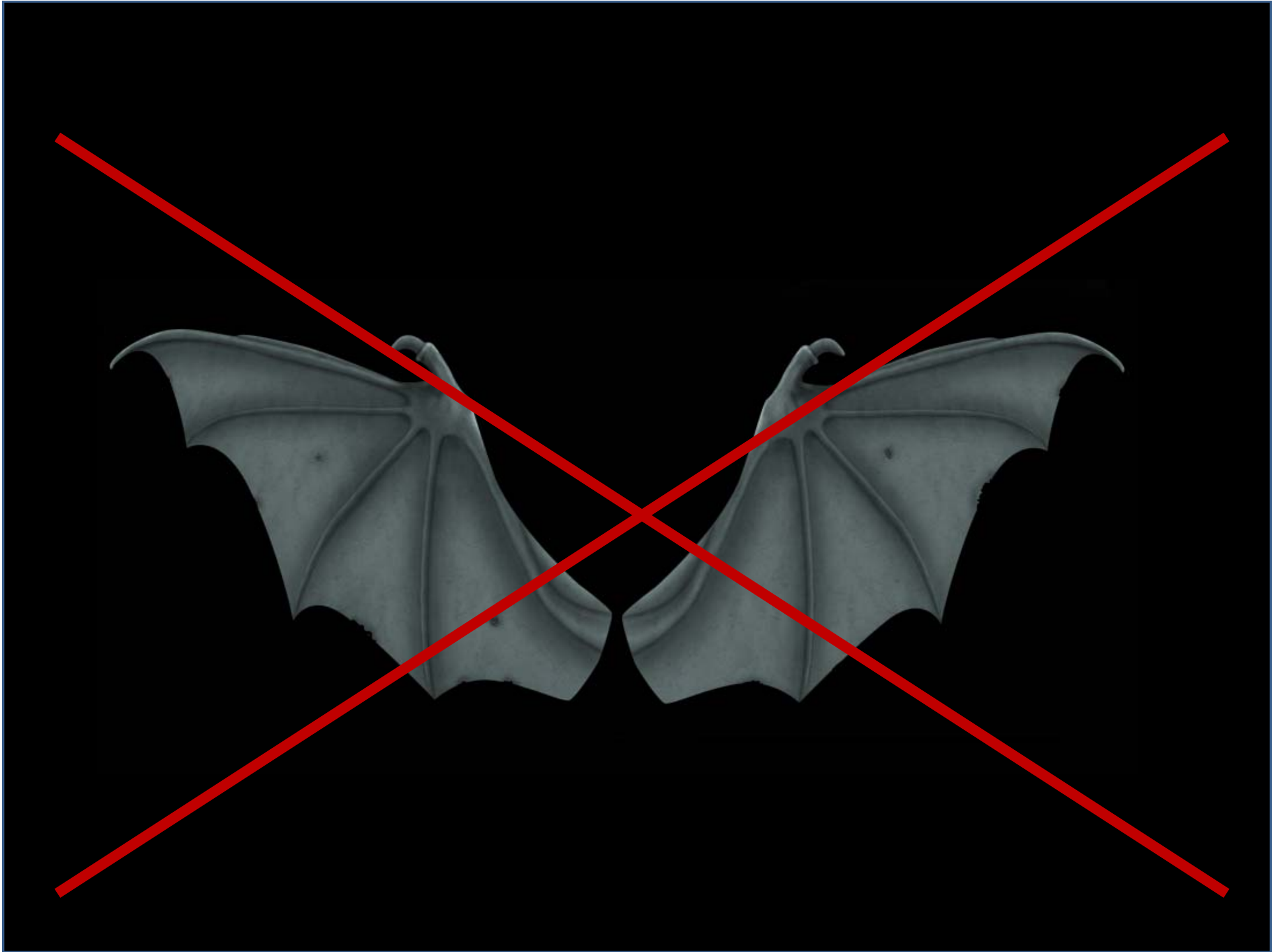
Average : **102 lm/W**

Min : 80 lm/W

Max : 117 lm/W



Most of Energy efficient led luminaires are more efficient than ‘classical luminaires’



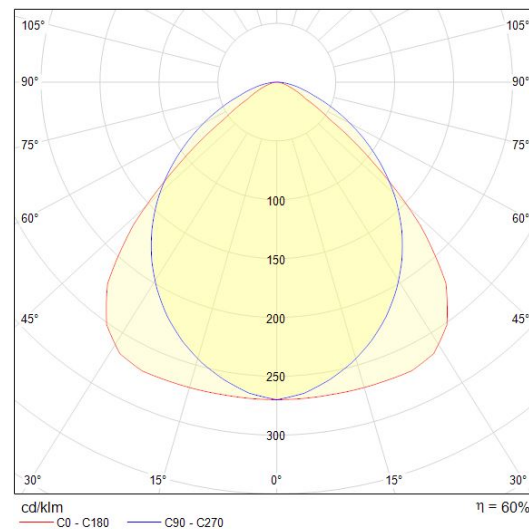
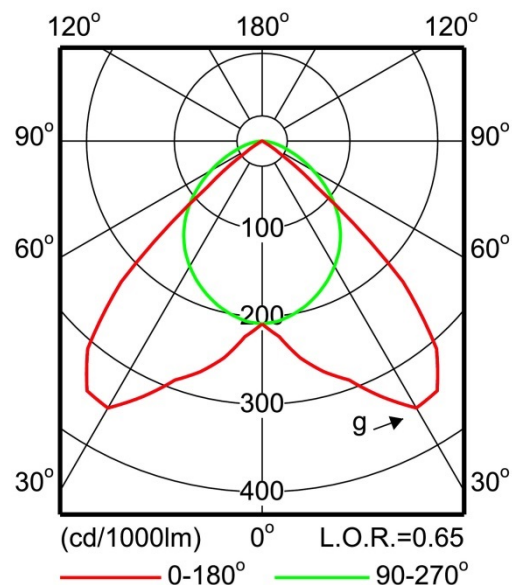
# Retrofitting with luminaires 60x60

## Led solutions - fotometric impact

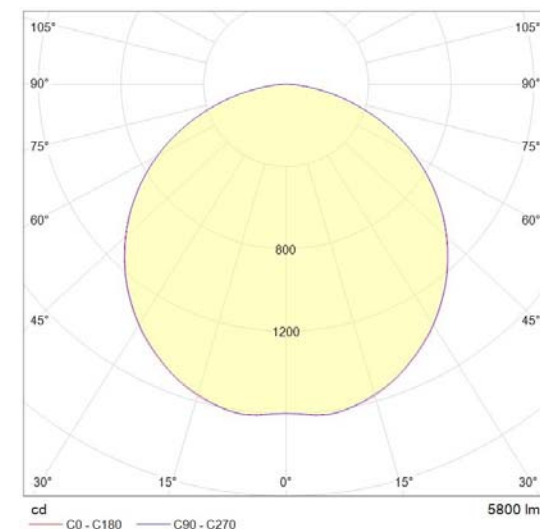
Luminaires with TL lamps : “Batwing” profile for C0-C180

Luminaires with leds : lots of different profiles

from nearly “ideal” to diffuse



Luminaire with TL-5






Luminaire with leds

**By retrofit with led luminaires, required illuminances can be not reached, even as the total light flux is the same → be aware of the fotometric impact**

# Retrofitting with luminaires 60x60

## Led solutions – Optics and luminous distribution

3 typologies in function of the optics design

- ❖ Power-led + reflector 
- ❖ (Power)led + lens 
- ❖ Leds + diffusor 



Group of light sources of (very) high luminance



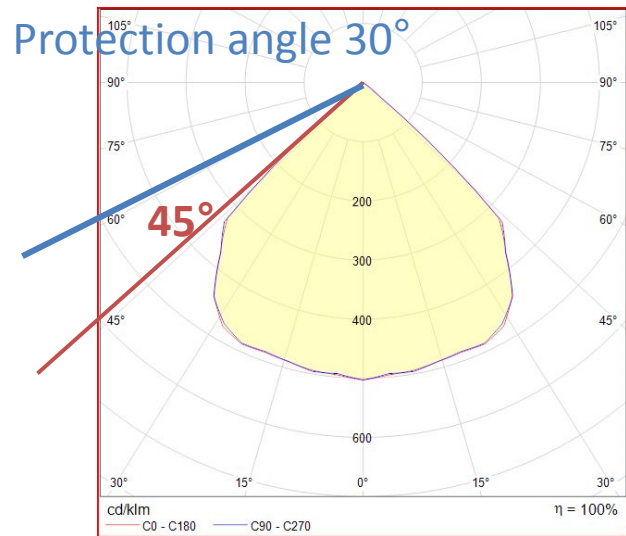
Group of light source of average luminance



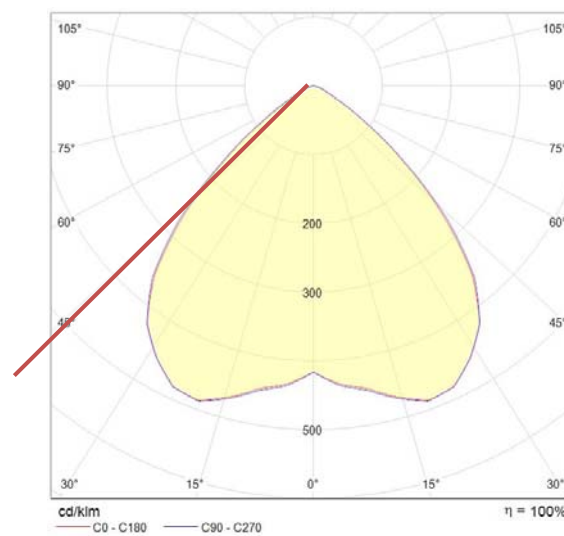
Diffuse light emitting surface of average luminance



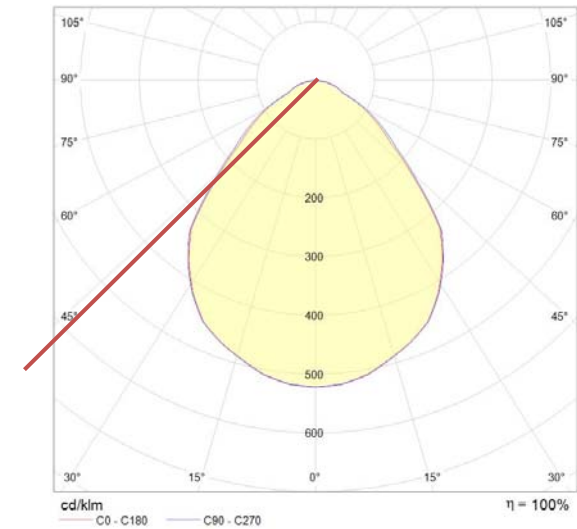
# Led solutions – Optics and luminous distribution



‘High oriented’ light pattern



‘Medium oriented’ light pattern



‘Diffuse’ light pattern

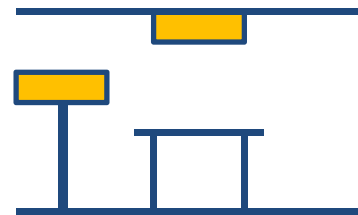
# Product data

#			Unit price (relative)	Power max (W)	Light Flux (lm)	Max Light intensity (cd)	UGR Table values (-)	Energy Efficiency (lm/W)	Lumen depreciation @ 50.000 h
L1			-13%	35,0	2 800	1 408	24,8	80	L80
L2			+13%	35,4	3 600	1 757	21,4	102	> L87
L3			-25%	35,5	3 400	2 190	21,6	96	L70@ 30000h
L4			+25%	29,0	3 400	1 802	18,4	115	L80 / B50
L5			-10%	37,0	4 000	1 724	19,6	108	L75
L6			+38%	45,0	4 561	2 363	18,9	101	L75

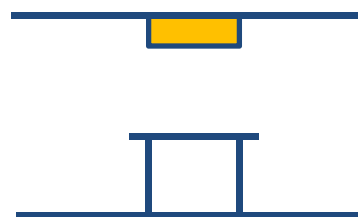
source : Catalogue of manufacturers

## Different lighting schemes

S1 : General lighting : 300 lx + Extra Task lighting



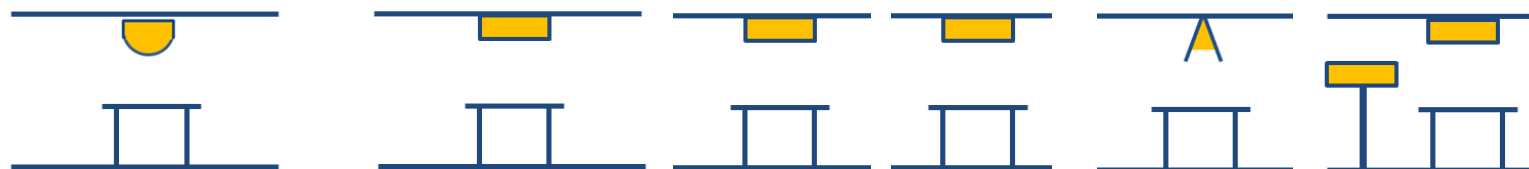
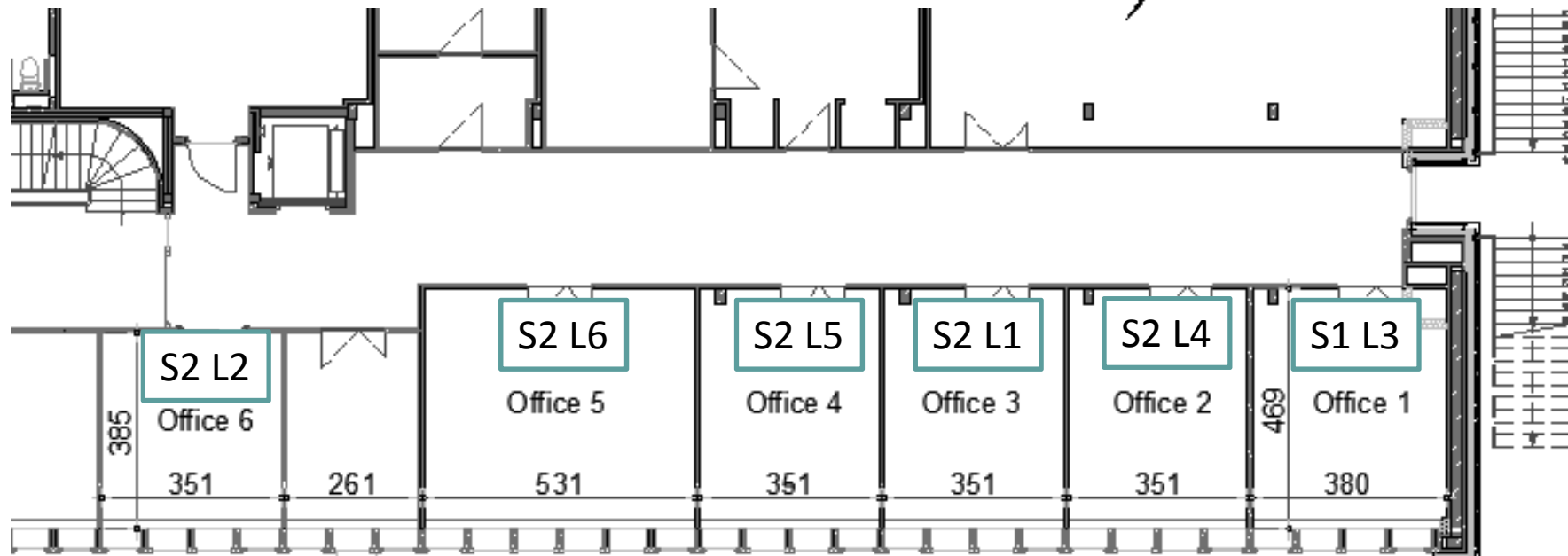
S2 : Task lighting 500 lx

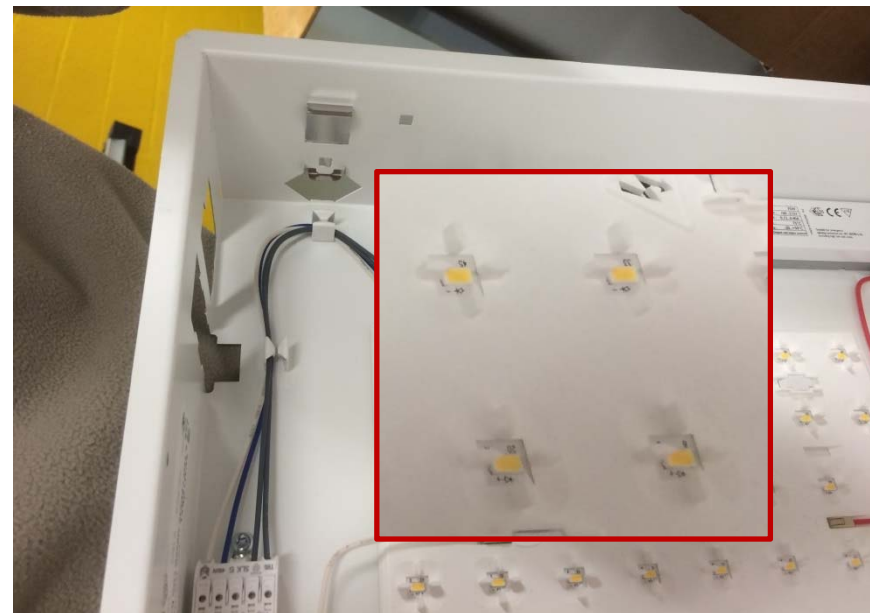
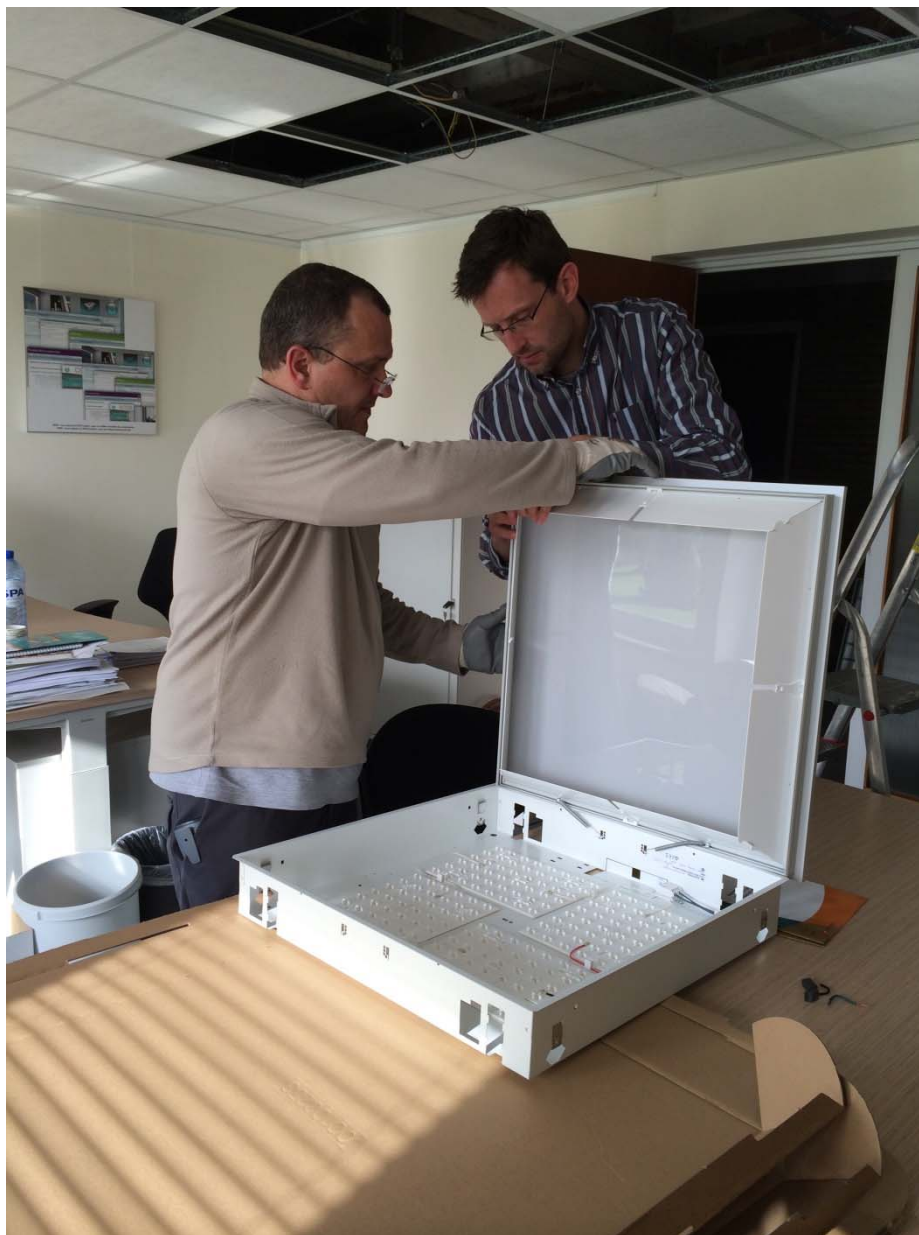


S3 : General lighting : 500 lx

→ Not handled in the study

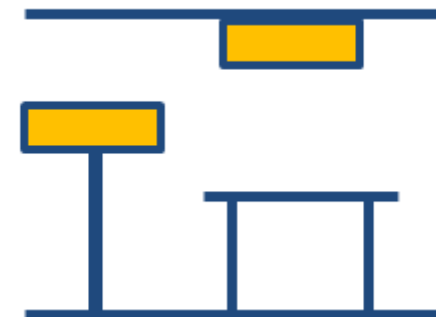
# 6 rooms







## S1 L3

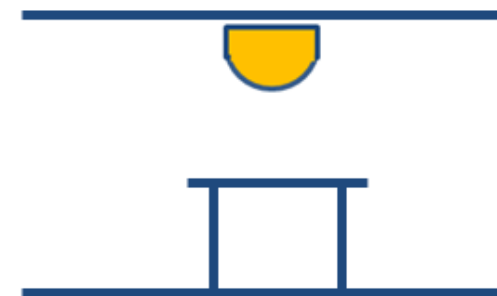


## S2 L1





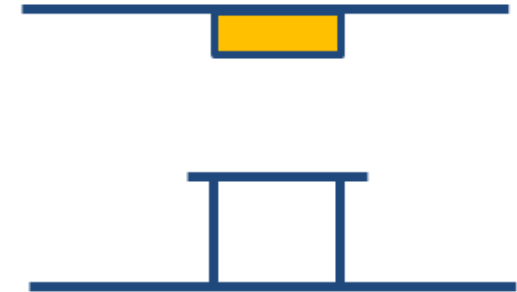
## S2 L2



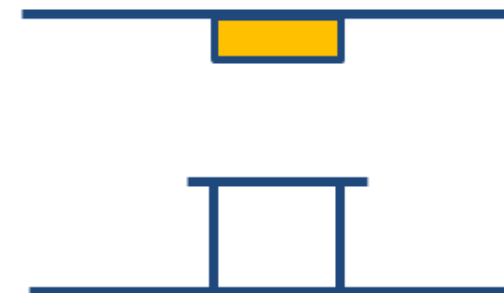
S2 L4









## S2 L5



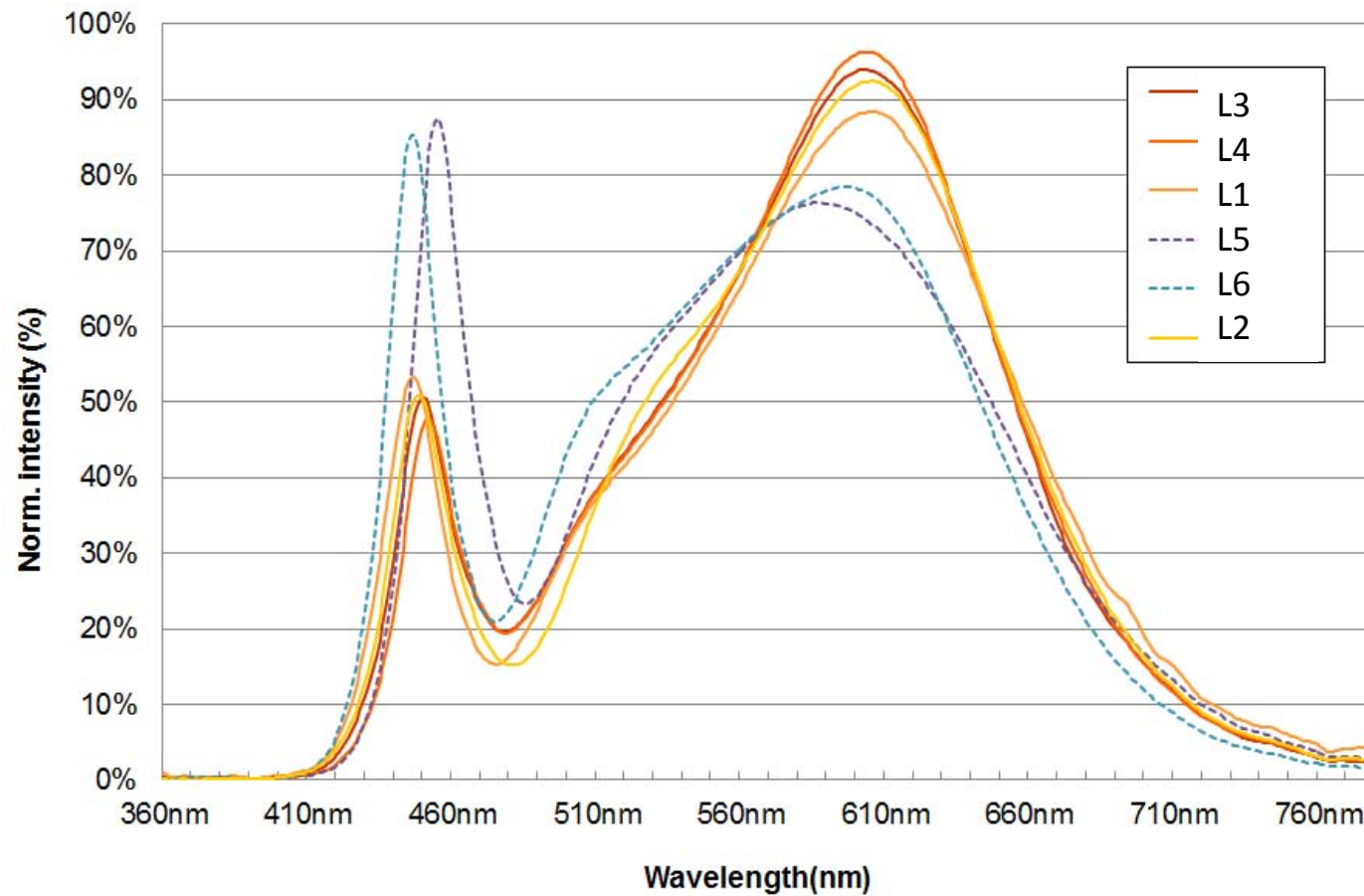
## S2 L6



# Results of the calculation

#		Power (W)	Luminous flux (lm)	Power / 500 lx (W)	E Task (lx)	E Waals (lx)	U Task (-)	UGR Soft values (-)	Energy Efficiency (lm/W)
S1L1		70	5600	5,1	421	67	0,75	-	80
S2L2		71	7200	4,3	503	98	0,82	16	102
S2L3		71	6800	4,3	505	88	0,77	20	96
S2L4		60	6800	3,7	492	83	0,81	14	115
S2L5		74	8000	4,2	509	130	0,84	23	108
S2L6		88	7560	5,7	526	106	0,83	19	101

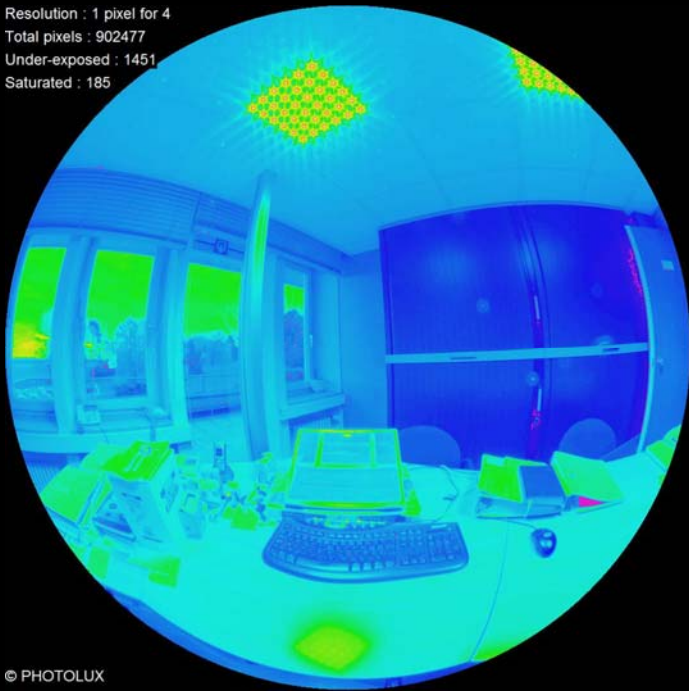
# Light spectrum



Colour temperature	L1	L2	L3	L4	L5	L6
Product data	3 000 K	3 000 K	3 000 K	3 000 K	4000 K	4 000 K
Measure	3 094 K	3 083 K	3 077 K	3 013 K	4 005 K	4 067 K

Colour rendering index	L1	L2	L3	L4	L5	L6
Product data	> 80	> 80	> 80	> 80	> 80	> 80
Measure	83	82	83	82	84	85

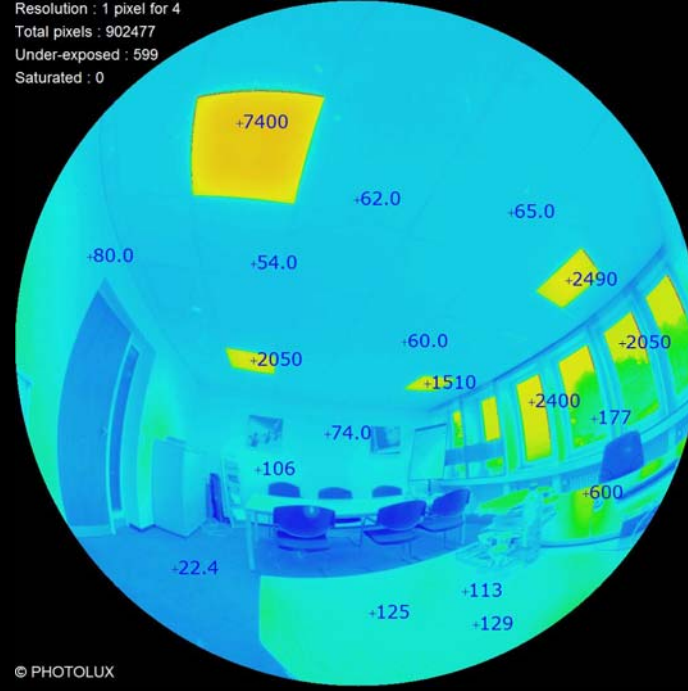
Resolution : 1 pixel for 4  
Total pixels : 902477  
Under-exposed : 1451  
Saturated : 185



Log (cd/m<sup>2</sup>)  
100000  
50000  
10000  
5000  
1000  
500  
100  
50  
10  
5  
1  
0.5  
0.1  
Luminances\* 1.0

© PHOTOLUX

Resolution : 1 pixel for 4  
Total pixels : 902477  
Under-exposed : 599  
Saturated : 0



Log (cd/m<sup>2</sup>)  
100000  
50000  
10000  
5000  
1000  
500  
100  
50  
10  
5  
1  
0.5  
0.1  
Luminances\* 1.0

© PHOTOLUX

Resolution : 1 pixel for 4  
Total pixels : 902477  
Under-exposed : 424  
Saturated : 14



Log (cd/m<sup>2</sup>)  
100000  
50000  
10000  
5000  
1000  
500  
100  
50  
10  
5  
1  
0.5  
0.1  
Luminances\* 1.0

© PHOTOLUX

Resolution : 1 pixel for 4  
Total pixels : 902477  
Under-exposed : 1657  
Saturated : 0



Log (cd/m<sup>2</sup>)  
100000  
50000  
10000  
5000  
1000  
500  
100  
50  
10  
5  
1  
0.5  
0.1  
Luminances\* 1.0

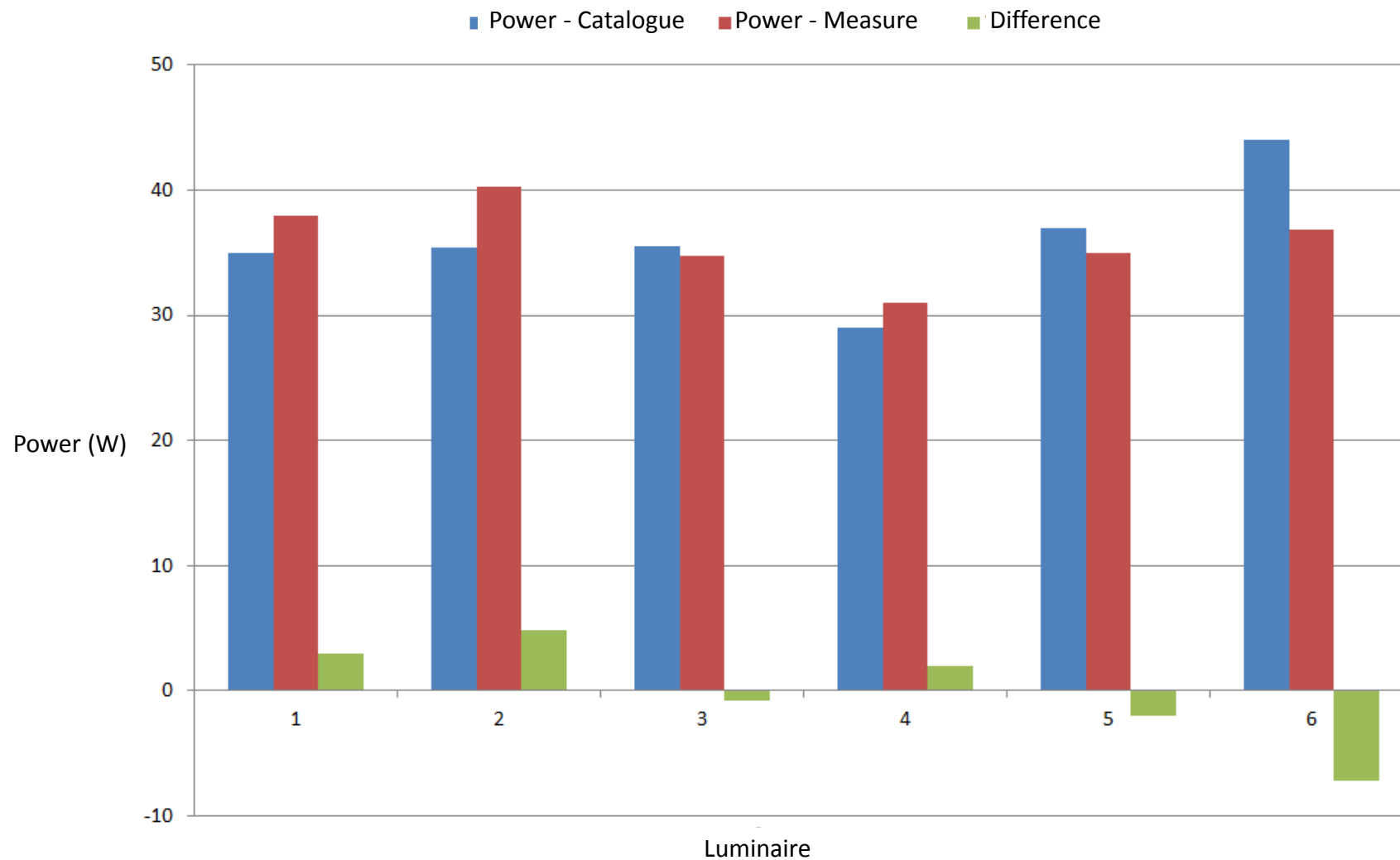
© PHOTOLUX



Colour temperature	L1	L2	L3	L4	L5	L6
Product data	3 000 K	3 000 K	3 000 K	3 000 K	4000 K	4 000 K
Measure	3 094 K	3 083 K	3 077 K	3 013 K	4 005 K	4 067 K

Colour rendering index	L1	L2	L3	L4	L5	L6
Product data	> 80	> 80	> 80	> 80	> 80	> 80
Measure	83	82	83	82	84	85

UGR	L1	L2	L3	L4	L5	L6
Product data	19,4	16,9	17,1	14,3	17,3	16,2
Measure	23,4	27,1	22,8	25,5	17,4	14,7





## ■ Guaranty : 5 years for all (reliable) manufacturer

### 2. Garantietermijn

garandeert dat haar producten vrij zijn van fabricagegebreken en/of gebrekkige materialen gedurende een garantietermijn van 5 jaar na indienstneming (d.w.z. 30 dagen nadat de goederen in de fabriek ter beschikking zijn gesteld), uitgezonderd de hierna vermelde producten:

- fluorescentielampen en HID-lampen: 1 jaar garantie
- batterijen van noodverlichtingunits, ingewerkt in armaturen, ter besturing van fluorescentielampen in noodmodus: 1 jaar garantie
- lichtregelsystemen zonder onderhoudscontract: 1 jaar garantie
- systemen voor noodverlichtingbeheer (zonder onderhoudscontract: 1 jaar garantie.
- D4-led-downlights: 6 jaar garantie

### 3. Garantievoorwaarden

WIJ BIEDEN U 5 JAAR FABRIEKSGARANTIE!

Hartelijk welkom bij het garantiebeheer van Wij garanderen niet alleen de hoogste productkwaliteit, maar zetten deze ook extra in de verf met de lichtgarantie. Wij garanderen u absolute tevredenheid wanneer u een product koopt. Registreer uw aankoop door de garantiecode in te voeren op deze pagina en geniet 5 jaar fabrieksgarantie op de door u gekochte en in de EU geïnstalleerde producten.

Wat moet u doen om aanspraak te kunnen maken op de uitgebreide garantie?

Wat moet u doen wanneer u een productgebrek vaststelt?

## ■ Caution !

‘5 years’ does not mean 43.800 operating hours  
(5 x 8.760 operating hours)

# Conclusions - 1

## BBRI – case study

### ■ Illuminance :

- 2 luminaires by room
- Solution ‘lighting scheme 1’ with portable luminaires is not possible (due to the too low ceiling)

### ■ Glare :

- Differences between UGR tables and measurements
- One situation to avoid : Abdrupt ‘cut off angles’
- No direct look at the led
- 2 plates (layers) for luminaires with diffusors

## Conclusions 2

### BBRI – case study

- **Installed power :**
  - Reduction by a factor of 3 compared with the existing situation
  - 5 W/m<sup>2</sup> is the target for offices (room level)
  - 6,5 W/m<sup>2</sup> is the target for the BBRI office building (global)
- **Luminous efficacy of the products :**
  - > 100 lm/W
- **Caution with the colour temperature :**
  - → no ‘luminaire mix’ (different manufacturers and different led types) in the same room
  - 4.000 K → High Ra, Higher efficiency, Best for high illuminance (cfr. Kruithof diagram)

# Conclusions 3

## BBRI – case study

- Depreciation of the light flux and life time :
  - 5 years Guaranty
  - Objective : L80/B70 - 50.000 hours
  - Proposed approach :
    - Dimming of the luminaires and automatic adaptation of the luminous flux in function of the depreciation
    - → Advantages :
      - Positive for the life time of the luminaire (Junction LED/LED modules + electronic components)
      - Positive for the limitation of the total energy use

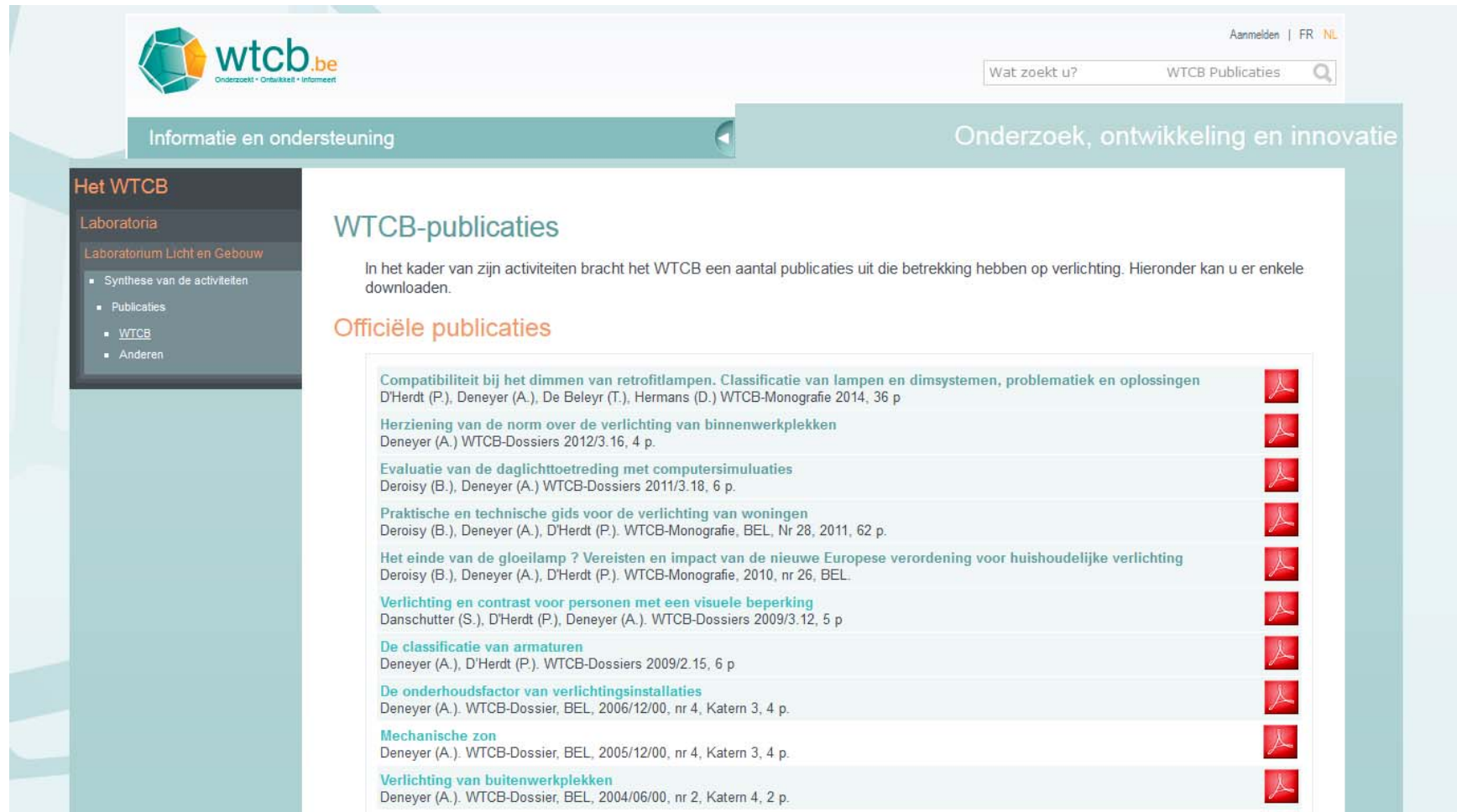
## Conclusions 4

- Performances of products are extremely variable
  - Need of information and need to make comparison !
- Light distribution is important for the visual comfort
  - Good light design for the room (direct/indirect illumination)
- Better determination of the task
  - Define visual tasks and work areas
- Caution with the glare
  - Test the products ! Limitation of the 'low level' UGR characterisation methods can not assume visual comfort
- Keep attention to the light quality
  - Colour Rendering Index, Colour temperature,.....



# Publications BBRI

[www.wtcb.be/go/publicatiesverlichting](http://www.wtcb.be/go/publicatiesverlichting)

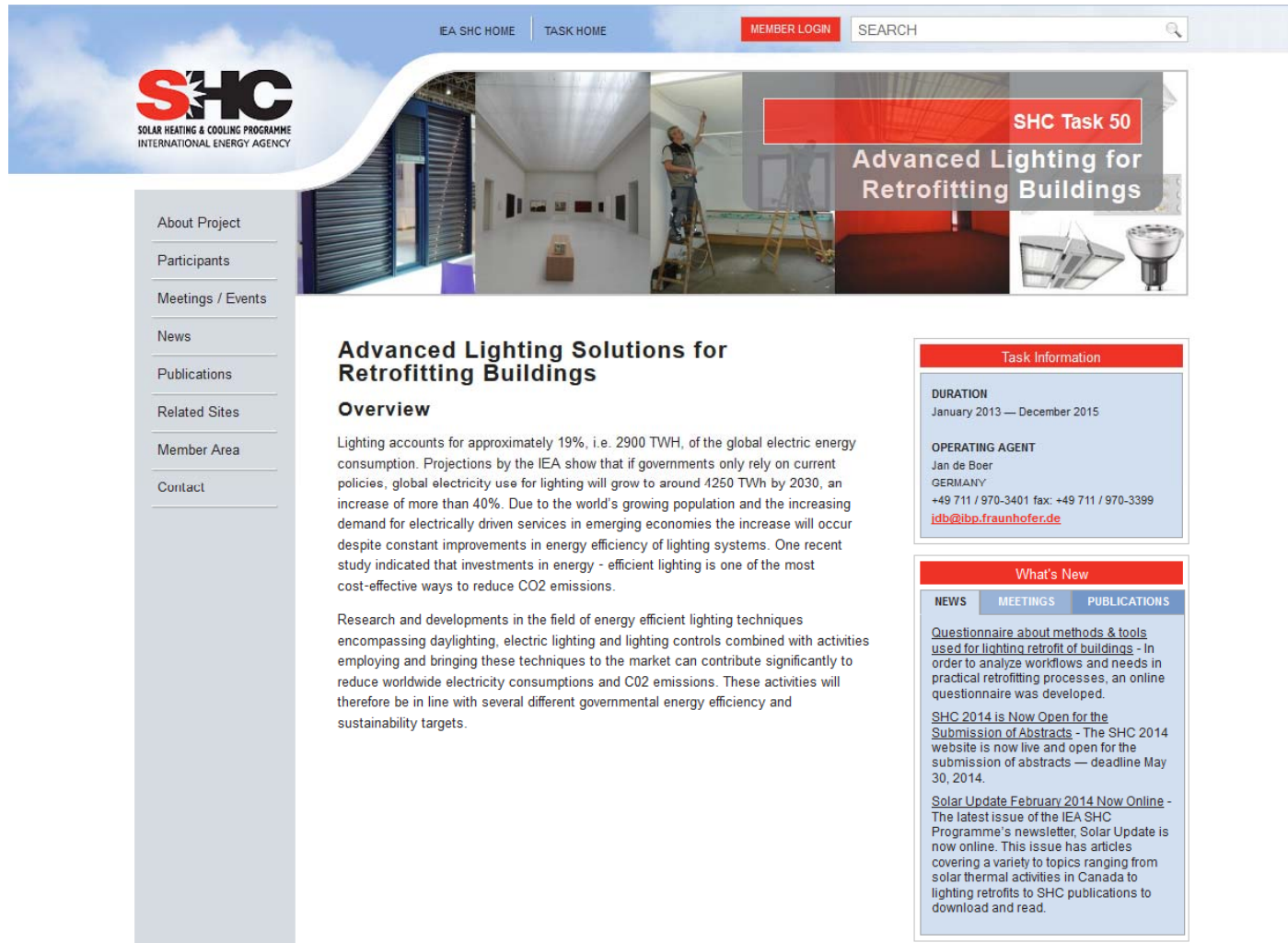


The screenshot shows the WTCB website interface. At the top left is the WTCB logo with the tagline 'Onderzoekt • Ontwikkelt • Informeert'. To the right is a search bar with the text 'Wat zoekt u?' and 'WTCB Publicaties'. Below the search bar are two main navigation tabs: 'Informatie en ondersteuning' and 'Onderzoek, ontwikkeling en innovatie'. On the left side, there is a sidebar menu titled 'Het WTCB' with sub-items: 'Laboratoria', 'Laboratorium Licht en Gebouw', 'Synthese van de activiteiten', 'Publicaties', 'WTCB', and 'Anderen'. The main content area is titled 'WTCB-publicaties' and contains a paragraph: 'In het kader van zijn activiteiten bracht het WTCB een aantal publicaties uit die betrekking hebben op verlichting. Hieronder kan u er enkele downloaden.' Below this is a section titled 'Officiële publicaties' which lists ten publications, each with a red PDF icon to its right.

Publicatie Titel	Auteurs	Publicatie Type	Jaar	Pagina's
Compatibiliteit bij het dimmen van retrofitlampen. Classificatie van lampen en dimsystemen, problematiek en oplossingen	D'Herdt (P.), Deneyer (A.), De Beleyr (T.), Hermans (D.)	WTCB-Monografie	2014	36 p
Herziening van de norm over de verlichting van binnenwerkplekken	Deneyer (A.)	WTCB-Dossiers	2012/3	16, 4 p.
Evaluatie van de daglichttoetreding met computersimulaties	Deroisy (B.), Deneyer (A.)	WTCB-Dossiers	2011/3	18, 6 p.
Praktische en technische gids voor de verlichting van woningen	Deroisy (B.), Deneyer (A.), D'Herdt (P.)	WTCB-Monografie, BEL	Nr 28, 2011	62 p.
Het einde van de gloeilamp? Vereisten en impact van de nieuwe Europese verordening voor huishoudelijke verlichting	Deroisy (B.), Deneyer (A.), D'Herdt (P.)	WTCB-Monografie	2010, nr 26	BEL.
Verlichting en contrast voor personen met een visuele beperking	Danschutter (S.), D'Herdt (P.), Deneyer (A.)	WTCB-Dossiers	2009/3	12, 5 p
De classificatie van armaturen	Deneyer (A.), D'Herdt (P.)	WTCB-Dossiers	2009/2	15, 6 p
De onderhoudsfactor van verlichtingsinstallaties	Deneyer (A.)	WTCB-Dossier, BEL	2006/12/00, nr 4, Katern 3	4 p.
Mechanische zon	Deneyer (A.)	WTCB-Dossier, BEL	2005/12/00, nr 4, Katern 3	4 p.
Verlichting van buitenwerkplekken	Deneyer (A.)	WTCB-Dossier, BEL	2004/06/00, nr 2, Katern 4	2 p.

# More information

<http://task50.iea-shc.org>



IEA SHC HOME | TASK HOME | MEMBER LOGIN | SEARCH

**SHC**  
SOLAR HEATING & COOLING PROGRAMME  
INTERNATIONAL ENERGY AGENCY

**SHC Task 50**  
**Advanced Lighting for Retrofitting Buildings**

- About Project
- Participants
- Meetings / Events
- News
- Publications
- Related Sites
- Member Area
- Contact

### Advanced Lighting Solutions for Retrofitting Buildings

#### Overview

Lighting accounts for approximately 19%, i.e. 2900 TWh, of the global electric energy consumption. Projections by the IEA show that if governments only rely on current policies, global electricity use for lighting will grow to around 4250 TWh by 2030, an increase of more than 40%. Due to the world's growing population and the increasing demand for electrically driven services in emerging economies the increase will occur despite constant improvements in energy efficiency of lighting systems. One recent study indicated that investments in energy - efficient lighting is one of the most cost-effective ways to reduce CO<sub>2</sub> emissions.

Research and developments in the field of energy efficient lighting techniques encompassing daylighting, electric lighting and lighting controls combined with activities employing and bringing these techniques to the market can contribute significantly to reduce worldwide electricity consumptions and CO<sub>2</sub> emissions. These activities will therefore be in line with several different governmental energy efficiency and sustainability targets.

#### Task Information

**DURATION**  
January 2013 — December 2015

**OPERATING AGENT**  
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#### What's New

**NEWS** | **MEETINGS** | **PUBLICATIONS**

[Questionnaire about methods & tools used for lighting retrofit of buildings](#) - In order to analyze workflows and needs in practical retrofitting processes, an online questionnaire was developed.

[SHC 2014 is Now Open for the Submission of Abstracts](#) - The SHC 2014 website is now live and open for the submission of abstracts — deadline May 30, 2014.

[Solar Update February 2014 Now Online](#) - The latest issue of the IEA SHC Programme's newsletter, Solar Update is now online. This issue has articles covering a variety of topics ranging from solar thermal activities in Canada to lighting retrofits to SHC publications to download and read.



With the support of :



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DG 04 Wallonie  
Projet SMART LED – AIE 50

**SMART**  **LED**



FOD Economie  
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Innoviris

*Technologische Dienstverlening “Ecobouwen en Duurzame ontwikkeling” in het Brussels Hoofdstedelijk Gewest gesubsidieerd door het Brussels Instituut voor Onderzoek en Innovatie (InnovIRIS)*



To be continued... in 2016