Relighting LED

Technology reconnaissance for a test case

Arnaud Deneyer

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 diffusor

Retrofitting with luminaires 60x60

Led Solutions – Energy efficiency

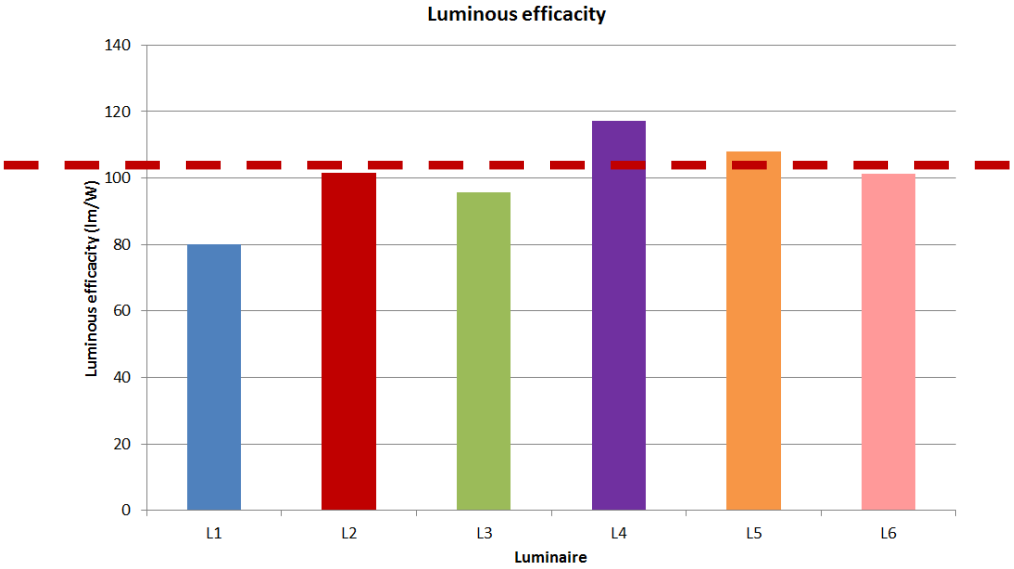
Set of 6 ‘new’ products with leds

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

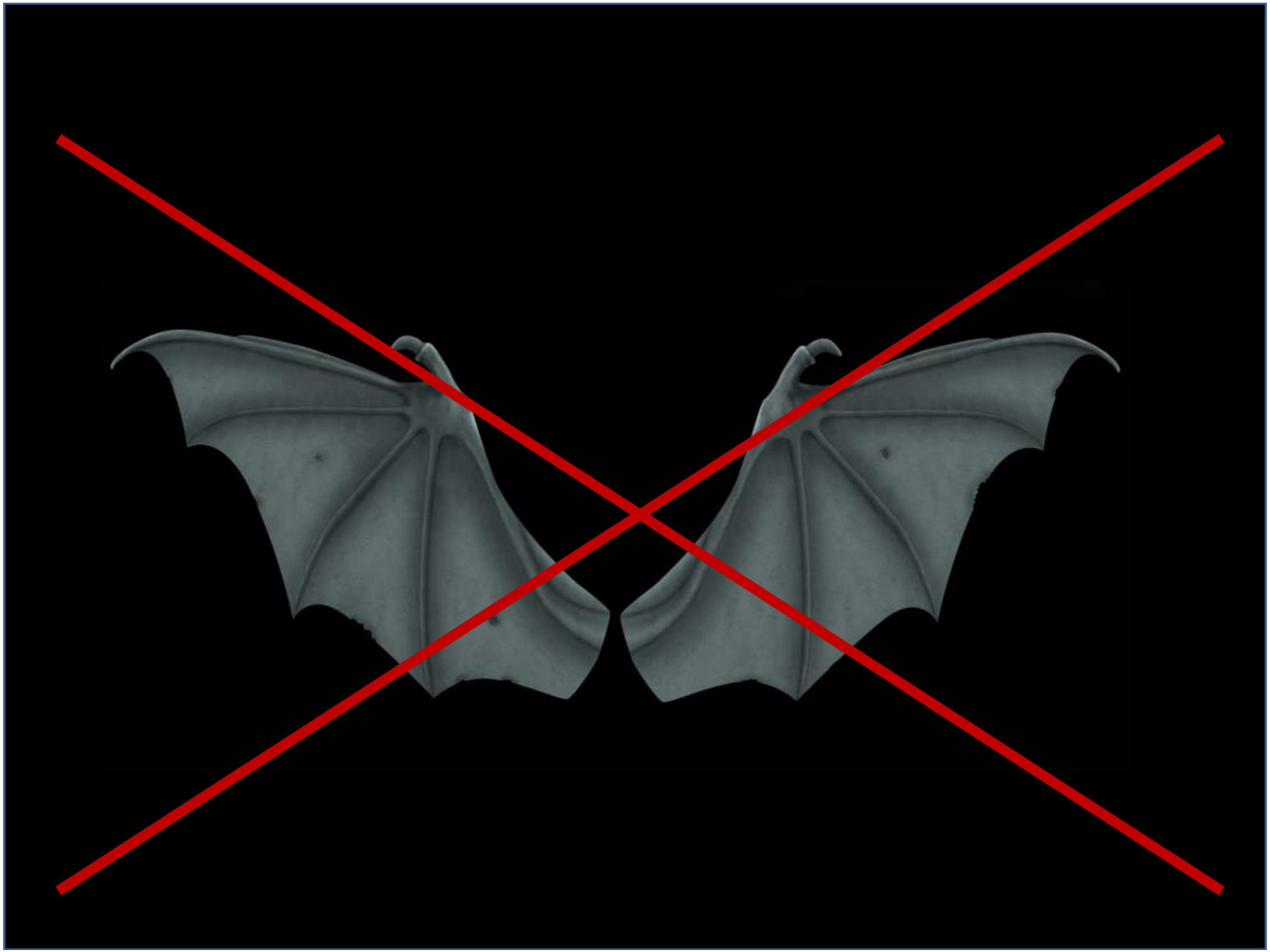
Energy efficiency *luminaires* (04/2014):

(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’



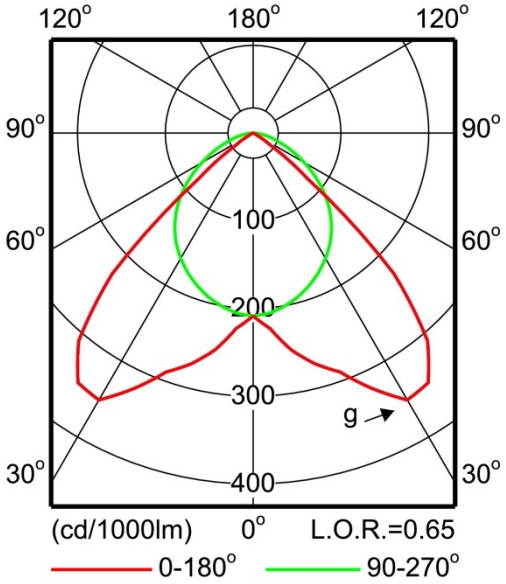
Retrofitting with luminaires 60x60

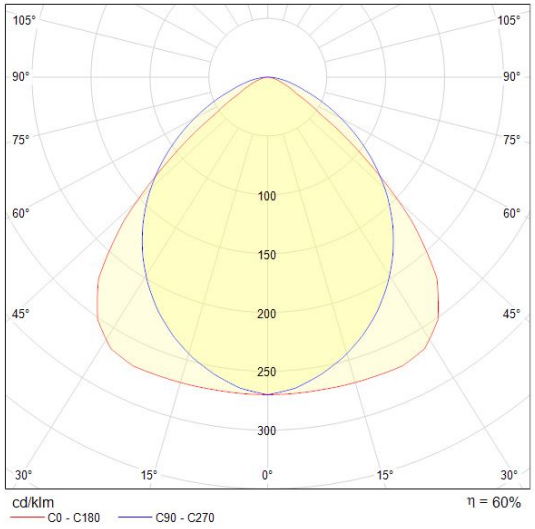
Led solutions - fotometric impact

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

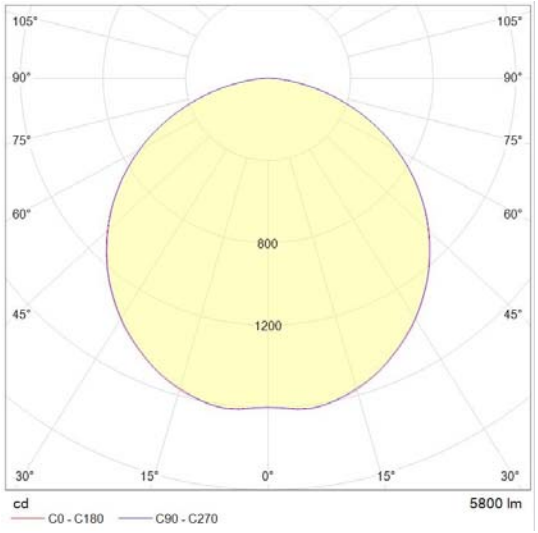
Luminaires with leds : lots of different profiles

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

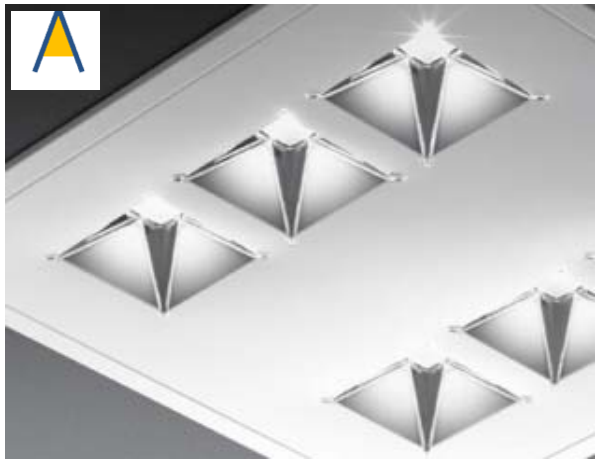
- Power-led + reflector
- (Power)led + lens
- Leds + diffusor

Group of light sources of (very) high luminance

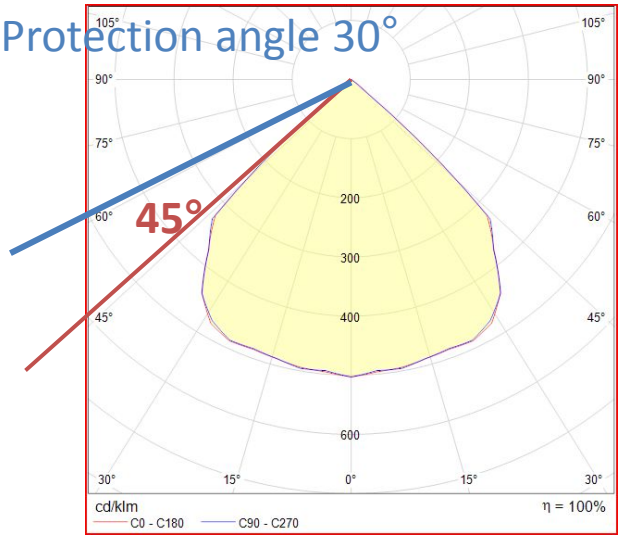
Group of light source of average luminance

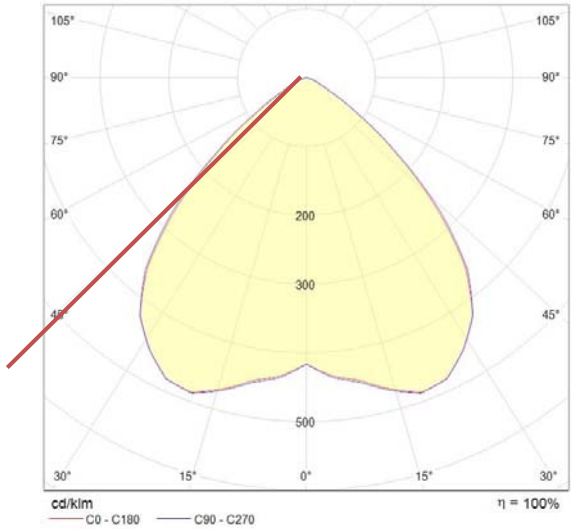
Diffuse light emitting surface of average luminance

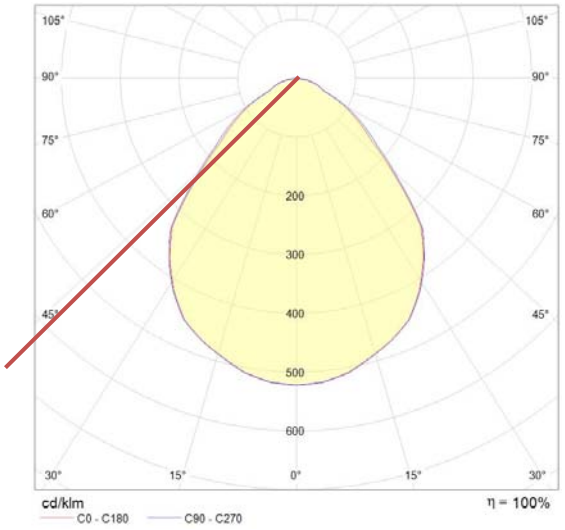
Led solutions – Optics and luminous distribution



Protection angle 30°







‘High oriented’ light pattern

‘Medium oriented’ light pattern

‘Diffuse’ light pattern

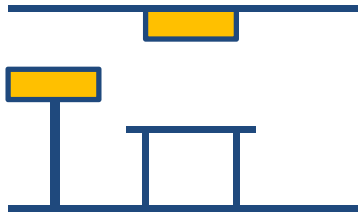
Product data

#			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

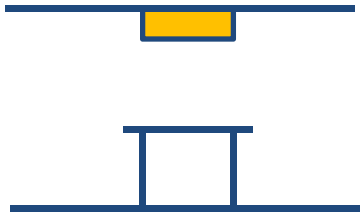
source : Catalogue of manufacturers

Different lighting schemes

S1 : General lighting : 300 lx + Extra Task lighting



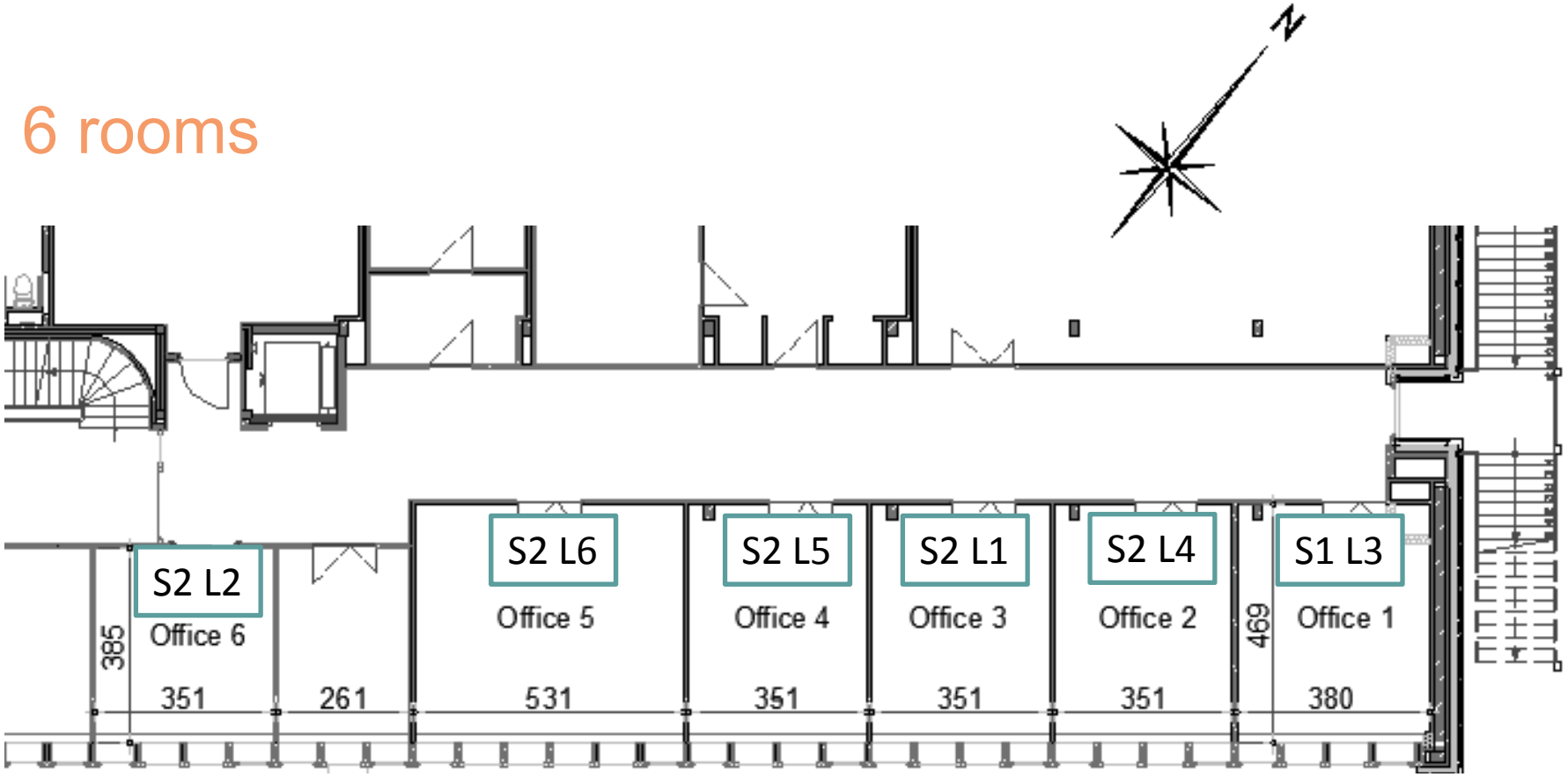
S2 : Task lighting 500 lx

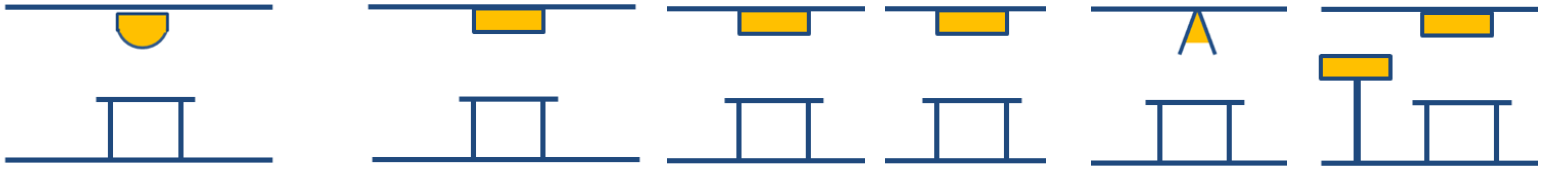


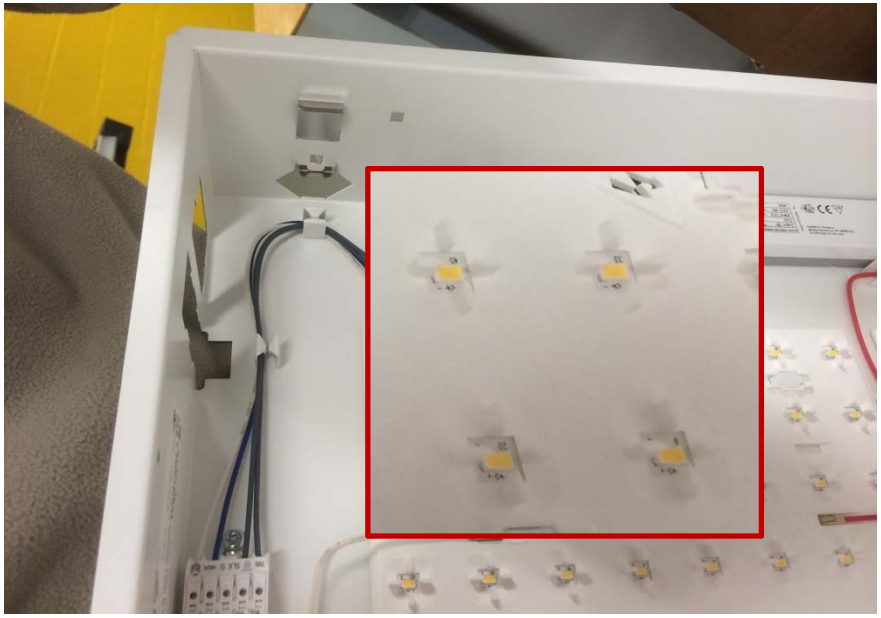
S3 : General lighting : 500 lx

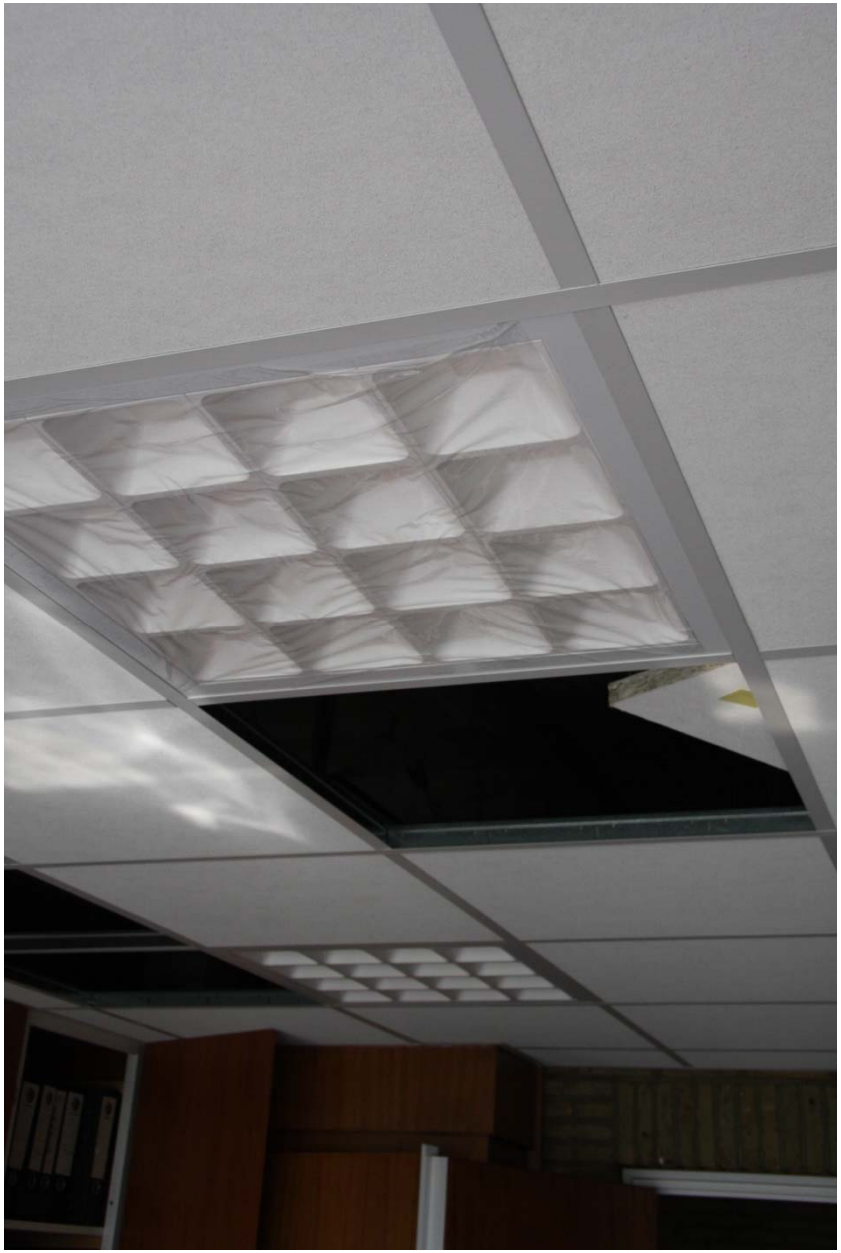
→ Not handled in the study

6 rooms

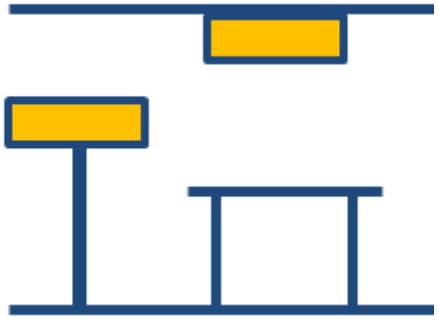

N
S2 L2
Office 6
S2 L6
Office 5
S2 L5
Office 4
S2 L1
Office 3
S2 L4
Office 2
S1 L3
Office 1
385
469
351
261
531
351
351
351
380







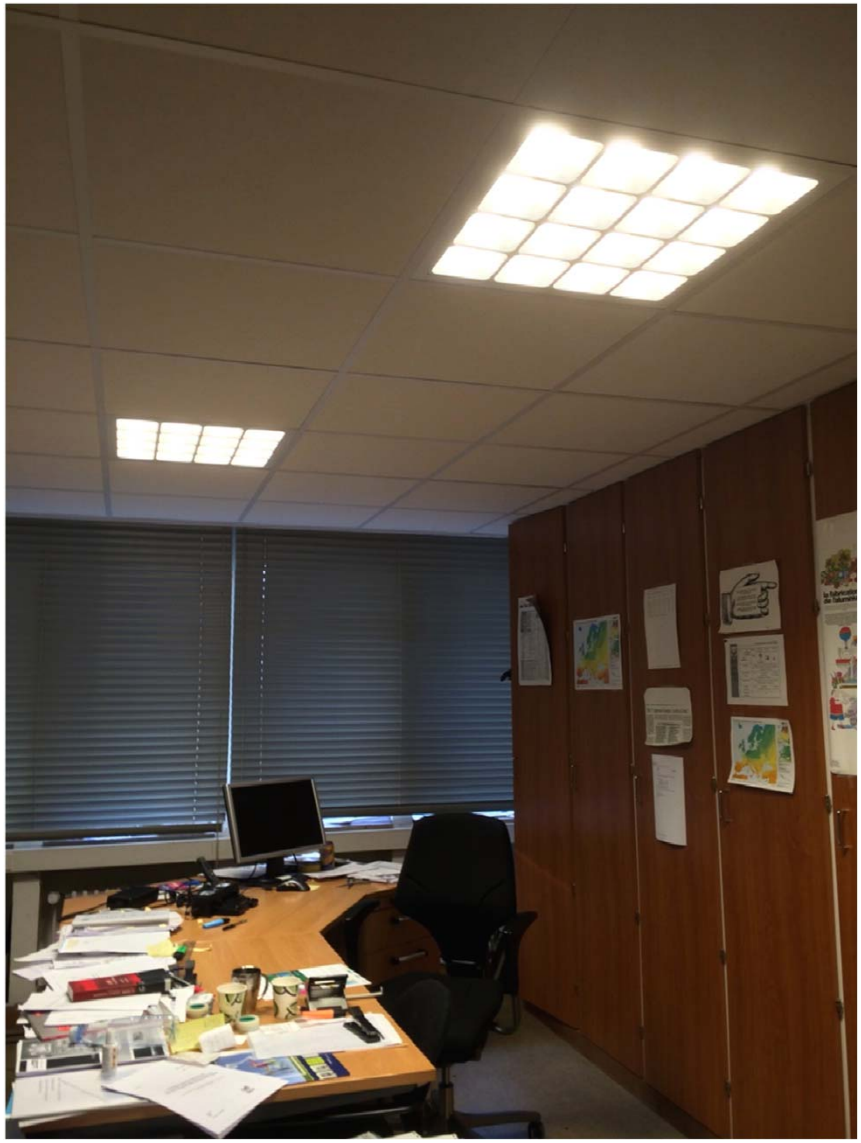
S1 L3

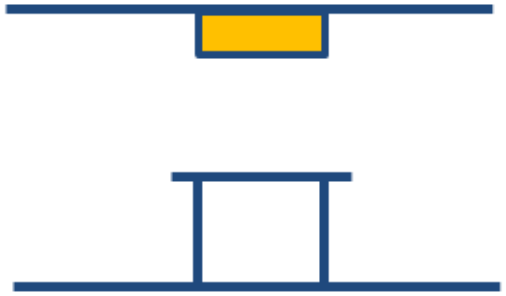


S2 L1

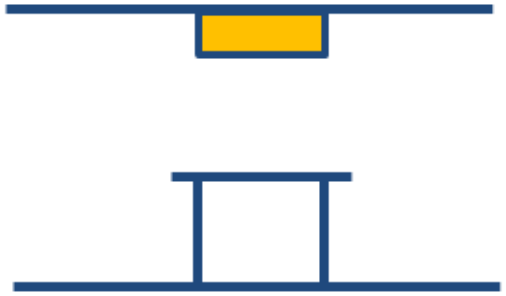
S2 L2

S2 L4

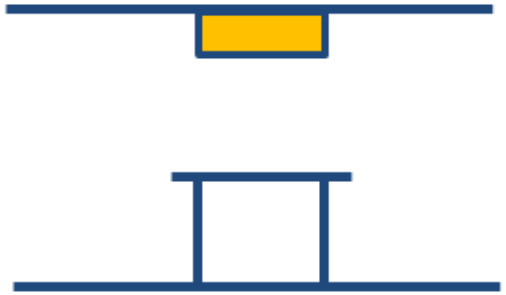




S2 L5



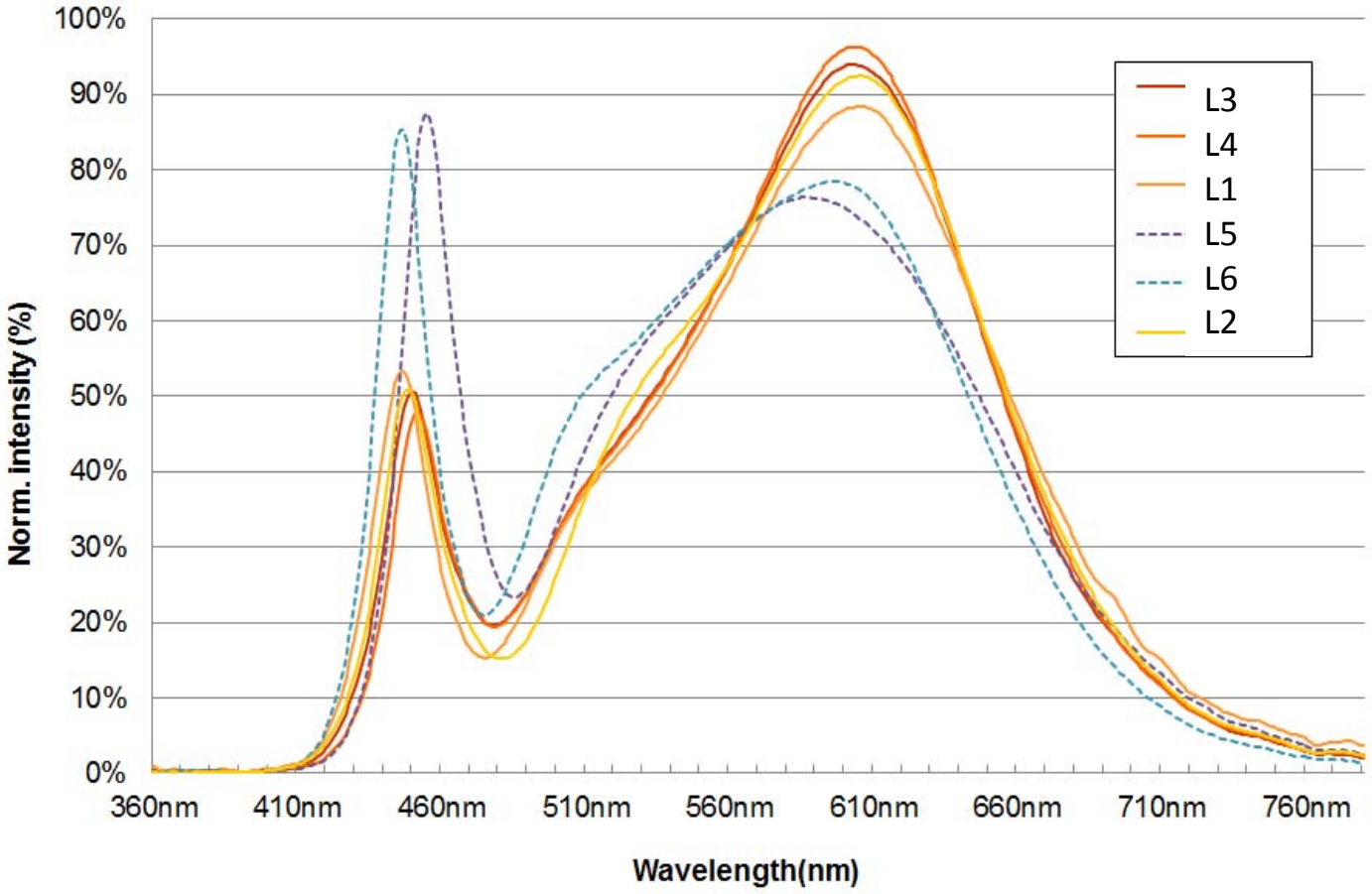
S2 L6



Results of the calculation

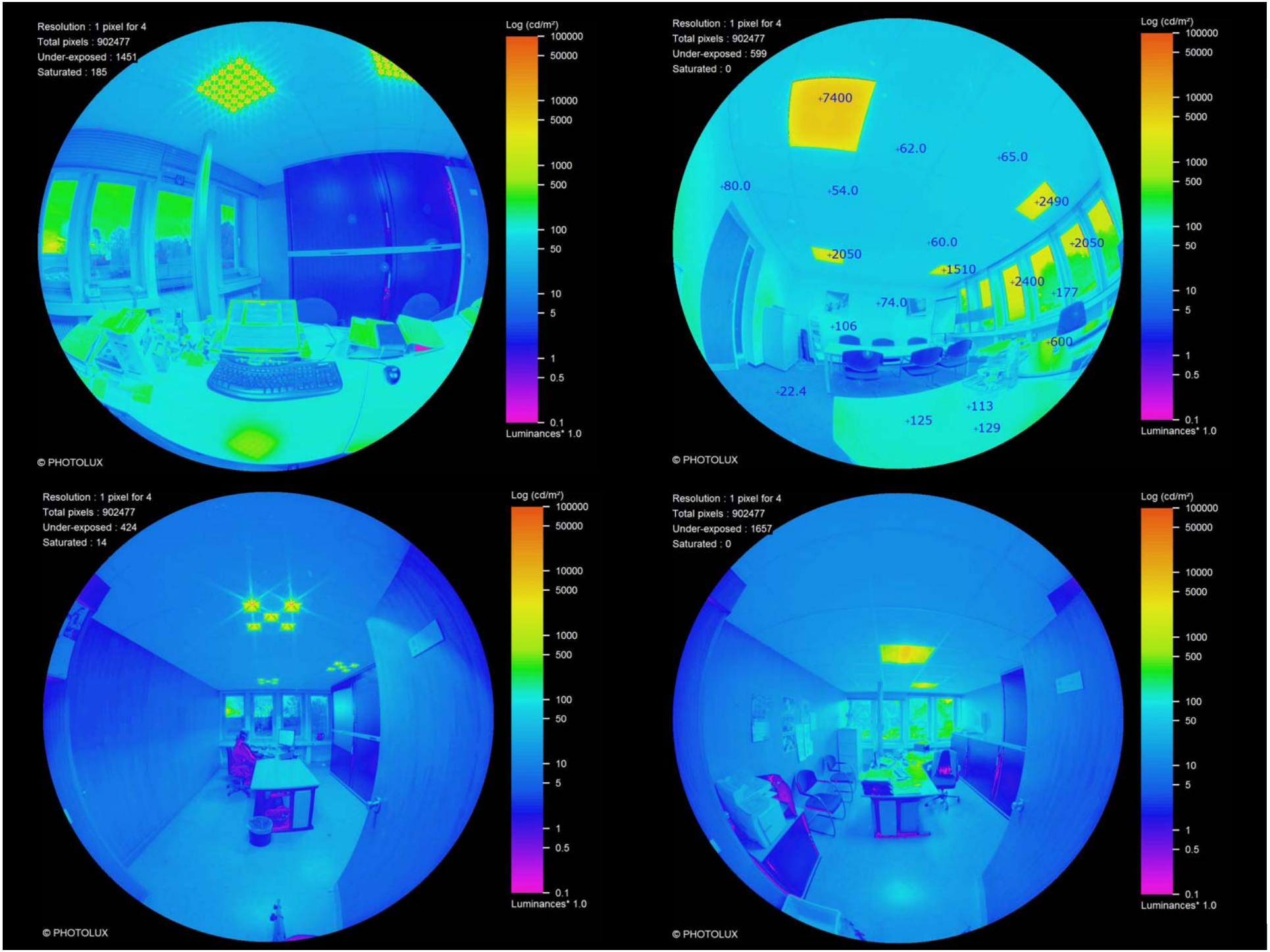
#		Power (W)	Luminous flux (lm)	Power / 500 lx (W)	E Task (lx)	E Waals (lx)	U Task (-)	UGR Soft values (-)	Energy Efficiency (lm/W)
S1L1		70	5600	5,1	421	67	0,75	-	80
S2L2		71	7200	4,3	503	98	0,82	16	102
S2L3		71	6800	4,3	505	88	0,77	20	96
S2L4		60	6800	3,7	492	83	0,81	14	115
S2L5		74	8000	4,2	509	130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

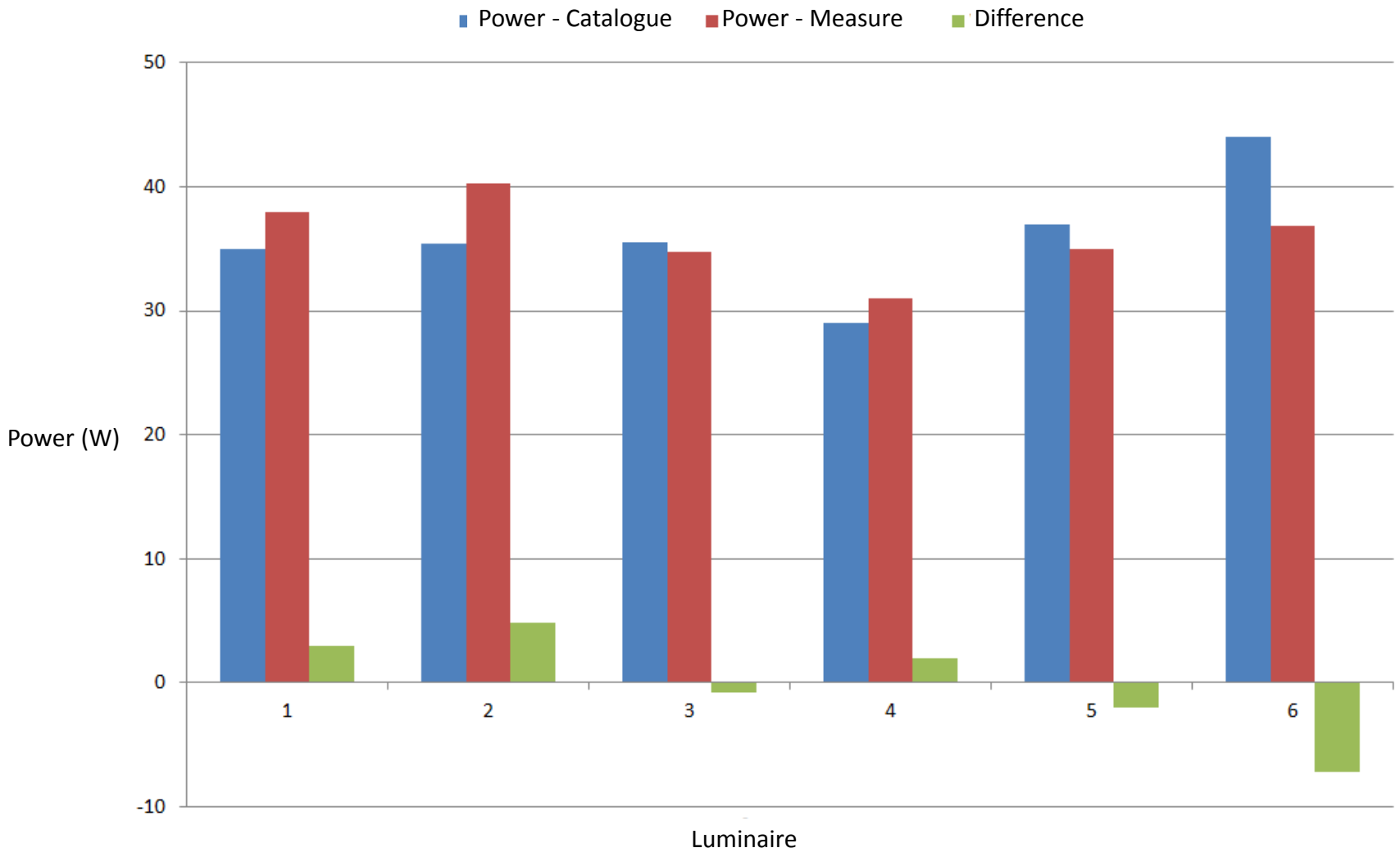
Colour rendering index	L1	L2	L3	L4	L5	L6
Product data	> 80	> 80	> 80	> 80	> 80	> 80
Measure	83	82	83	82	84	85


Resolution : 1 pixel for 4
Total pixels : 902477
Under-exposed : 1451
Saturated : 185
Log (cd/m²)
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
+7400
+62.0
+65.0
+80.0
+54.0
+2490
+60.0
+2050
+2050
+1510
+2400
+177
+74.0
+106
+600
+22.4
+113
+125
+129
Log (cd/m²)
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/m²)
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/m²)
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


Power - Catalogue
Power - Measure
Difference
Power (W)
50
40
30
20
10
0
-10
1
2
3
4
5
6
Luminaire

- 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^2 is the target for offices (room level)
  - 6,5 W/m^2 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 comparision !

- 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

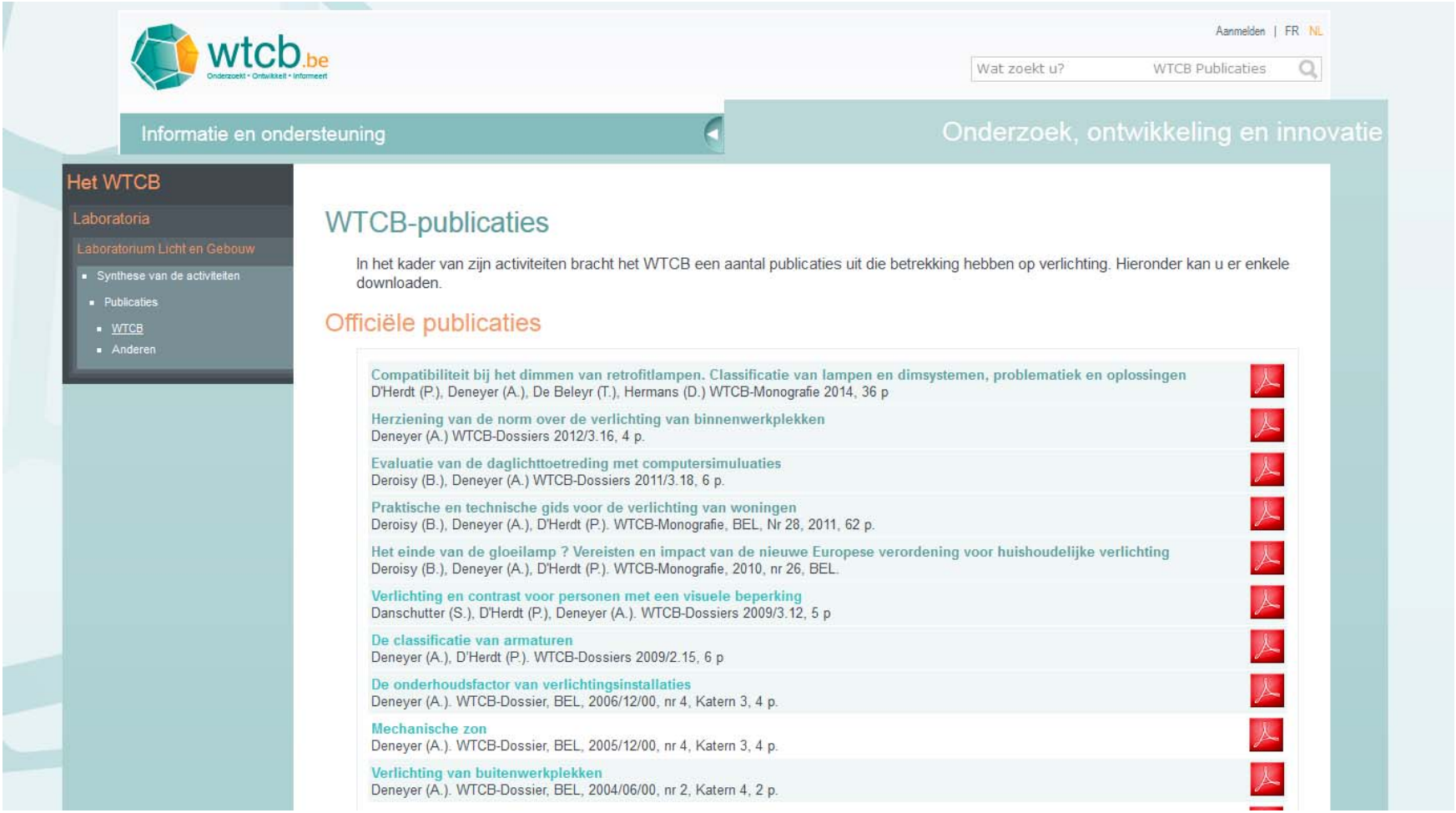
  Test the products ! Limitation of the ‘low level’ UGR characterisation methods can not assume visual comfort

- Keep attention to the light quality

  Colour Rendering Index, Colour temperature,….

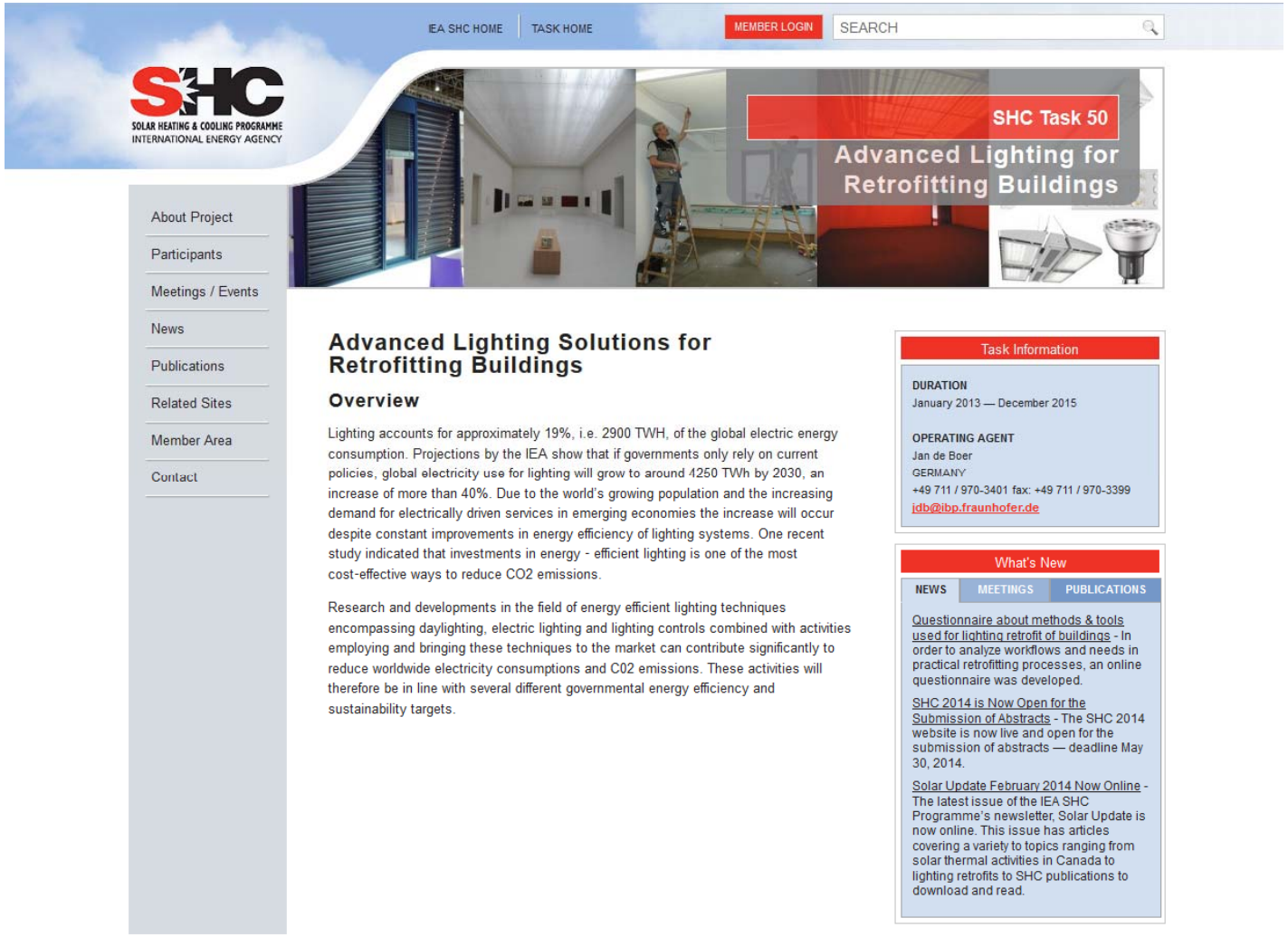
Publications BBRI

www.wtcb.be/go/publicatiesverlichting



More information

http://task50.iea-shc.org



With the support of :

DG 04 Wallonie
Projet SMART LED – AIE 50

FOD Economie
NA Energie 2014

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