Modern Lighting Design Principles

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Why lighting project?

- Degree: Batchelor of Electrical and Electronic Engineering
- Buildings are complex structures
  - Lighting
  - Power
  - Control
  - Data
  - Monitoring

Project planner

9	6/05/2024		PROJECT 2 BEGINS	TEST 1	Judging	LIGHTING SCIENCE
10	13/05/2024		ENGINEERING EVALUATION			EMERGENCY LIGHTING
11	20/05/2024		PAYBACK, CO2 EMISSION			ENGINEERING EVALUATION
12	27/05/2024					TEST 2, PA 2, REPORT

Photometric terms

- Luminous intensity of light source [cd]
- Luminous emittance [cd/klm] – directional
- Luminance [cd/m^2]
- Luminous flux [lm]

- Illuminance [lx]
- Uniformity of illuminance *u0*
- Light loss factor (maintenance factor)
- Unified glare rating UGR

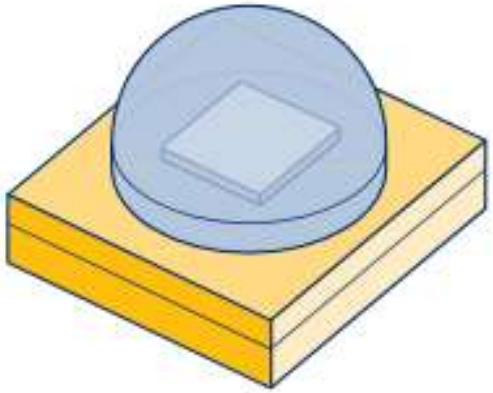
Luminaire LED type (manufacturer ETAP)

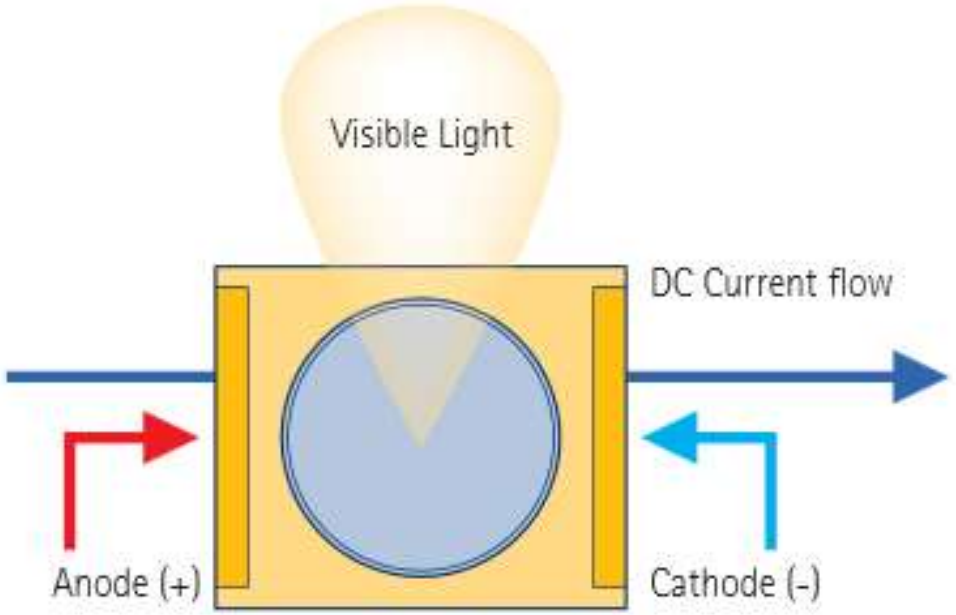
Luminaire LED type (manufacturer Iguzzini)

Driver (power supply)

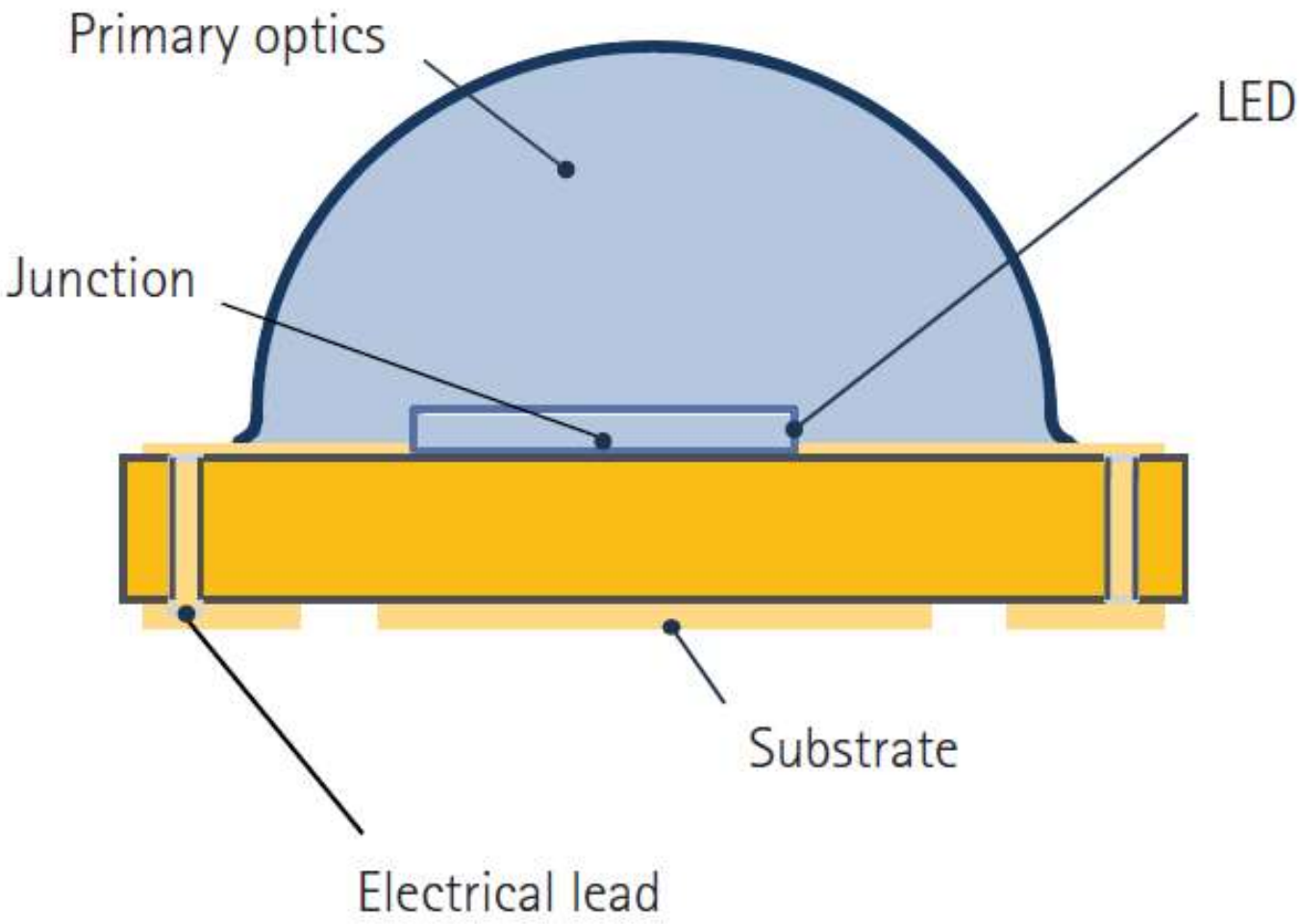
What is LED?

- LED stands for Light Emitting Diode.
- An LED is a semiconductor (diode) emitting light when current flows through it.

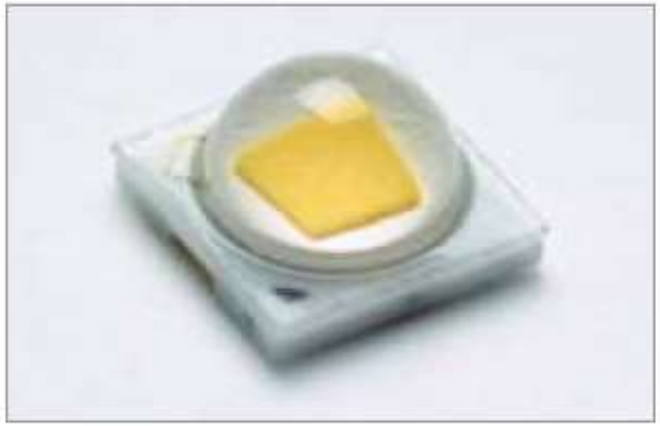




Structure of LED



LED chips



Cree XP-G LED component

Bridgelux LED component

LED modules and lamps

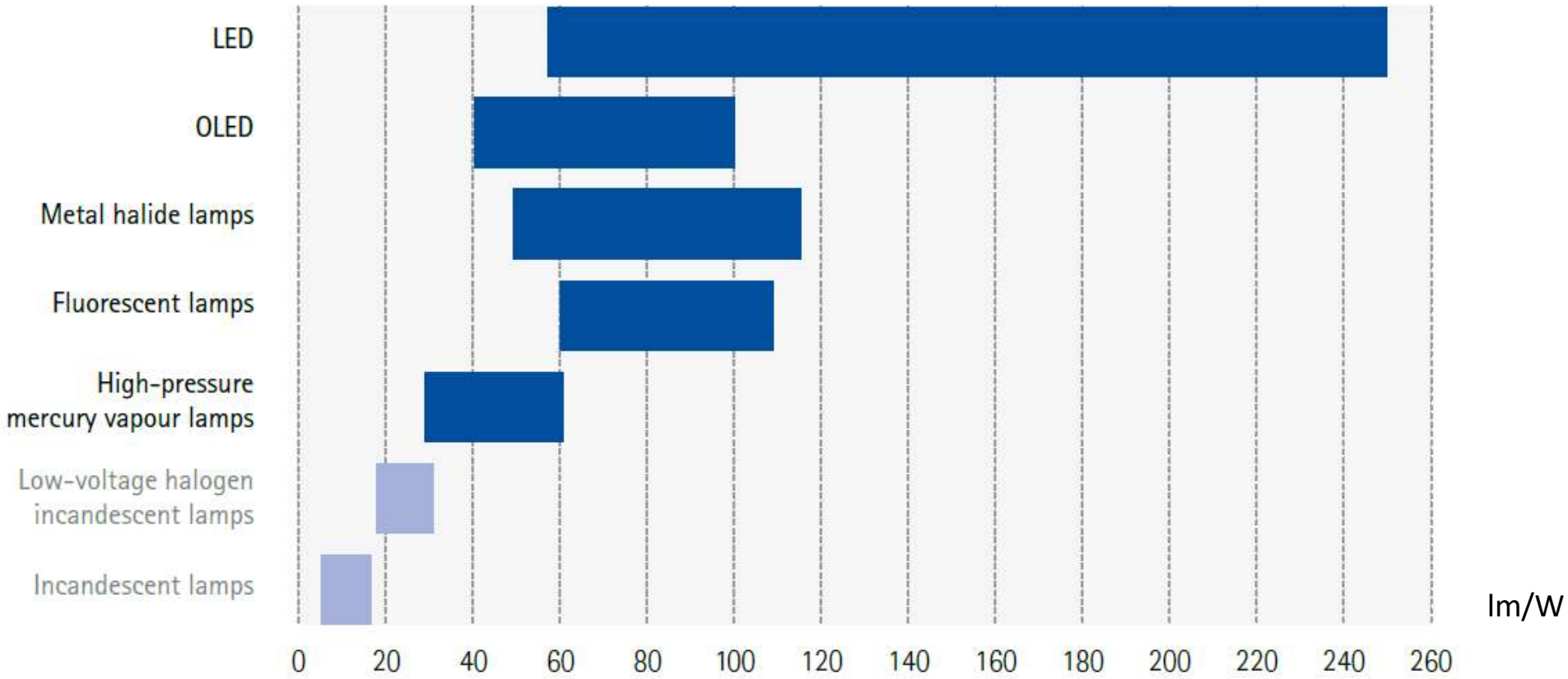
ETAP UM2 PCB

TG tube light

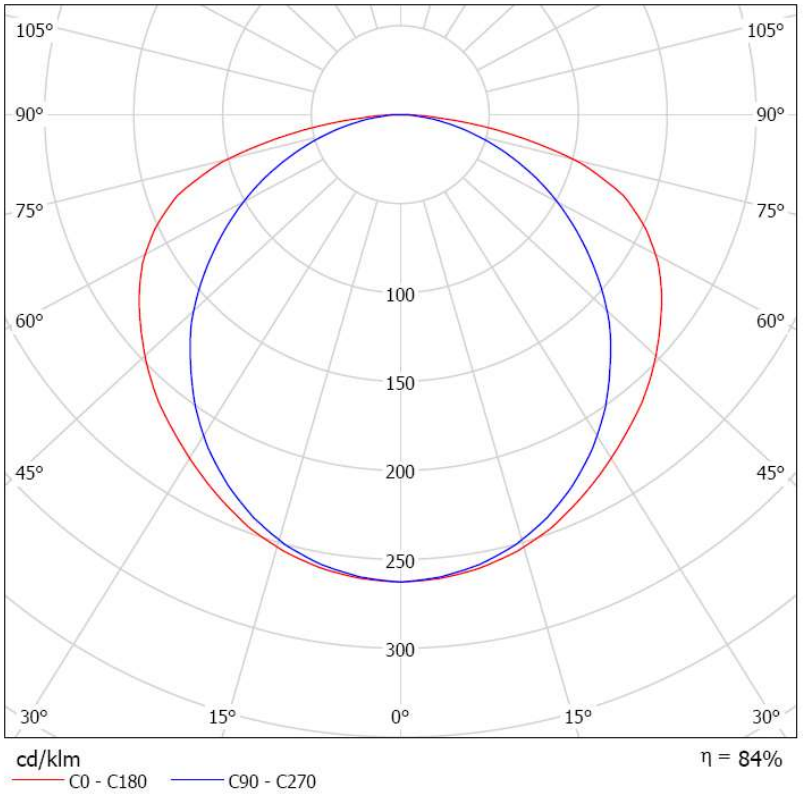
Osram PrevaLED

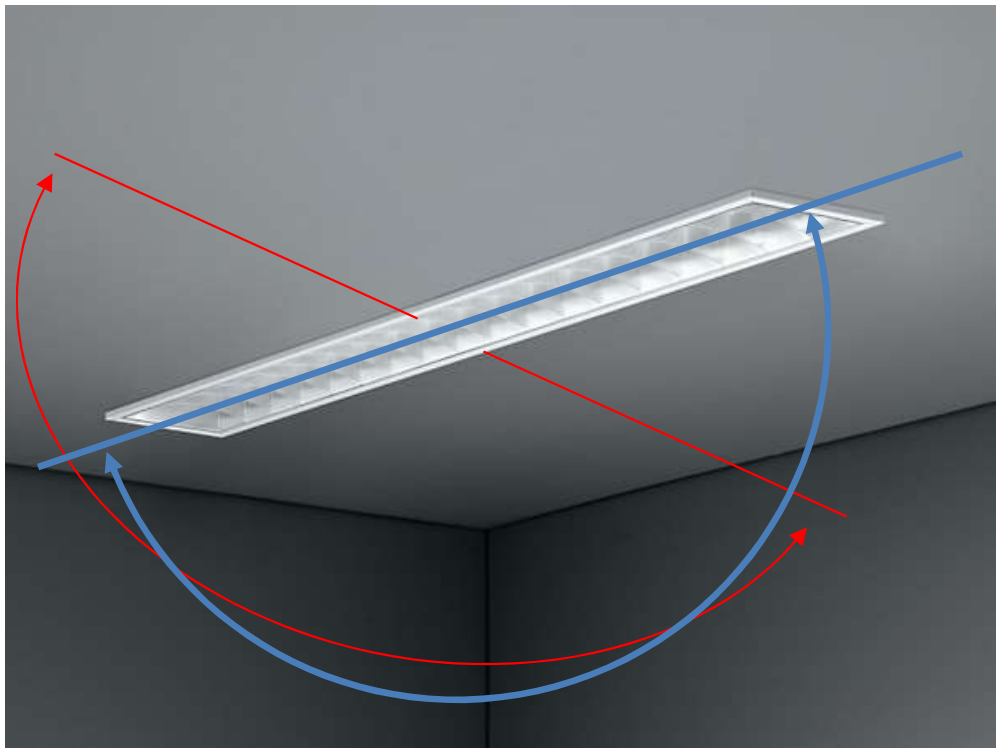
TG spot light

Efficacy of light sources (measured in lm/W)

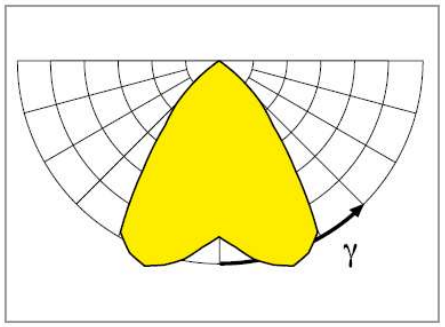


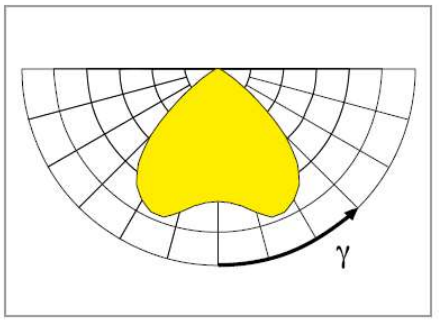
Luminous Emittance

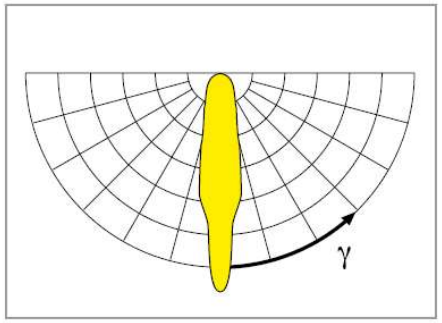


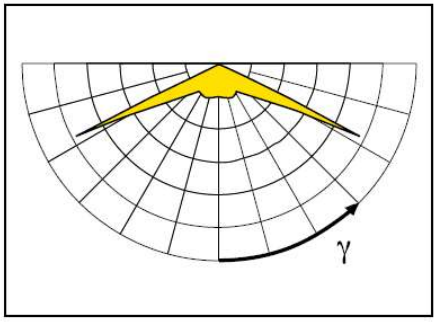


Luminous Emittance – examples

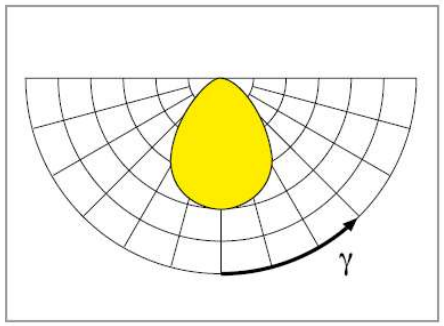


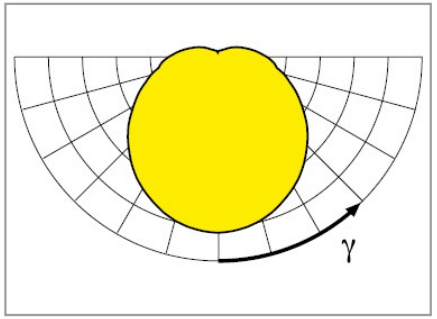


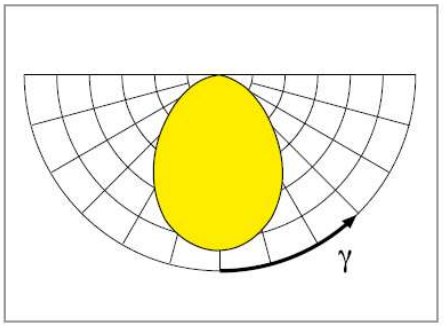




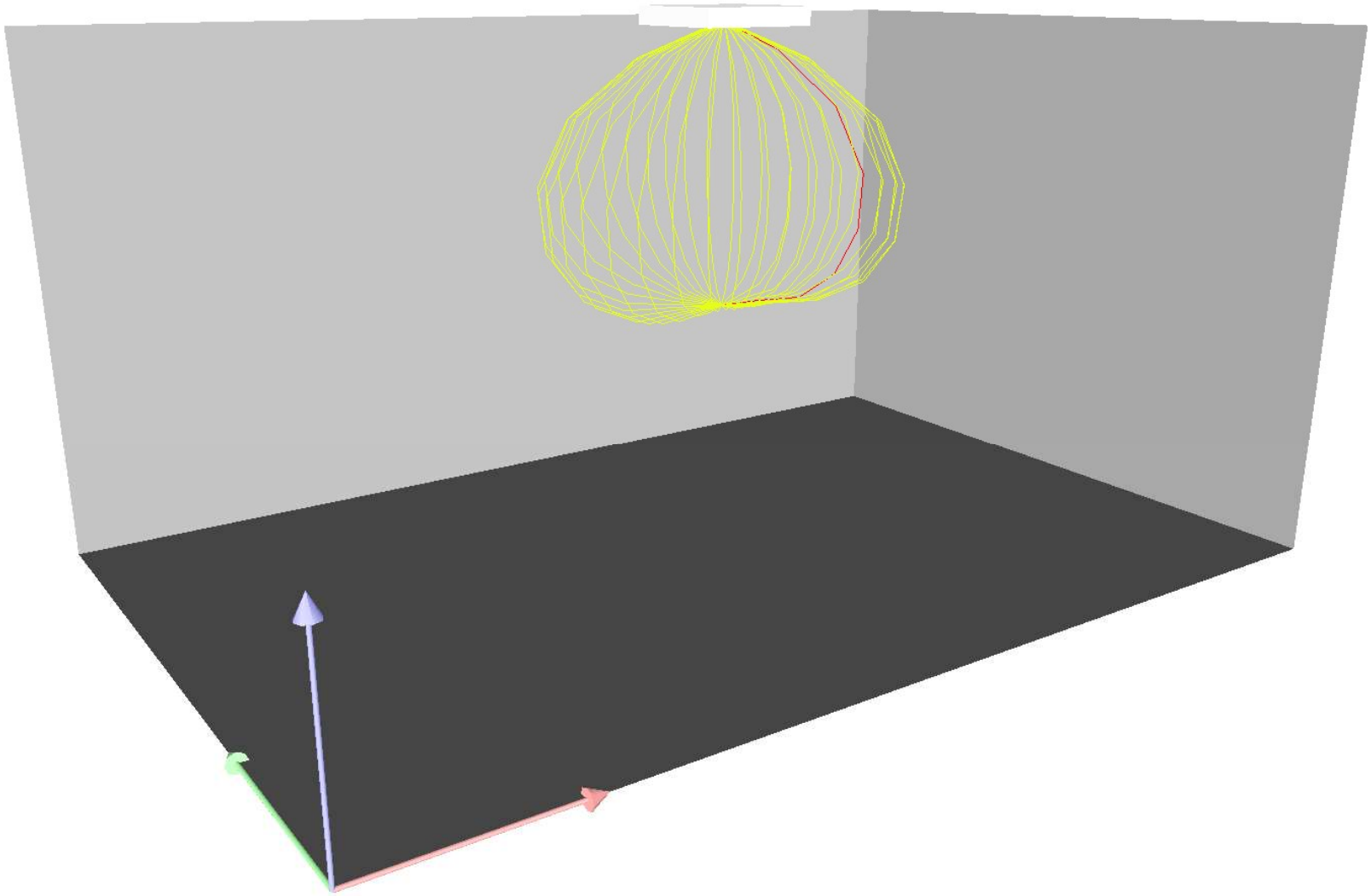
Luminous Emittance – examples



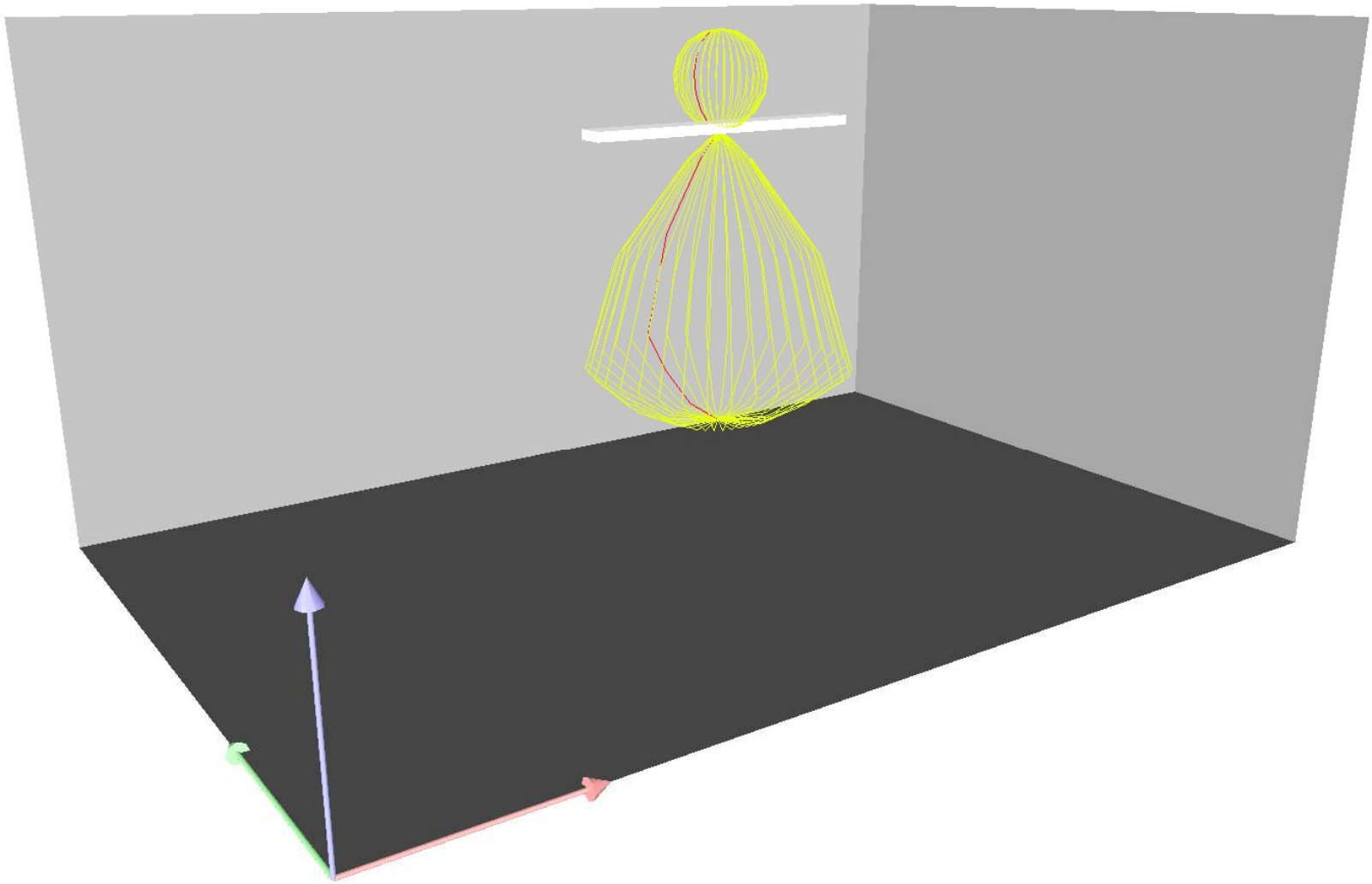




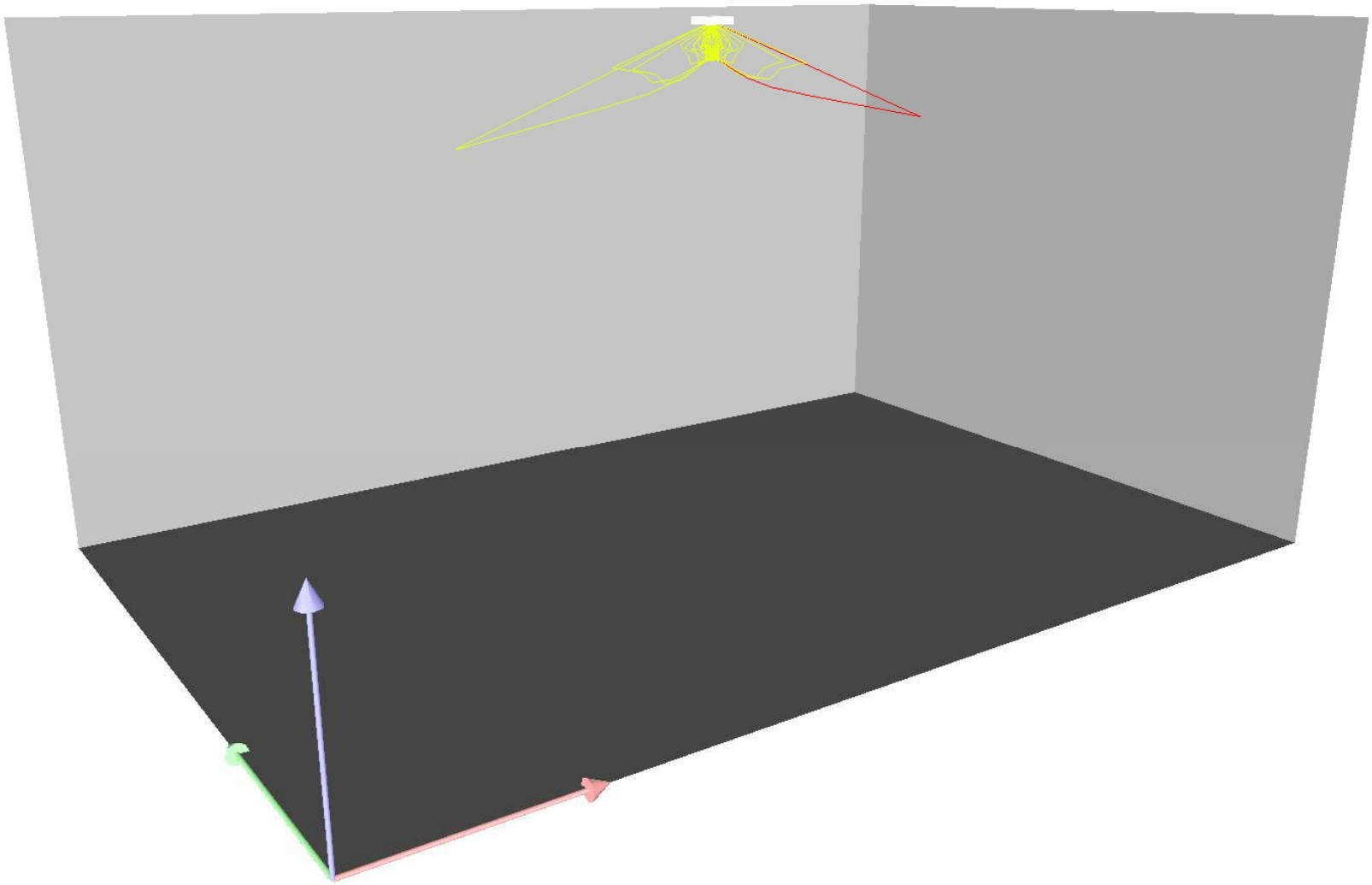
Luminous Emittance – recessed luminaires



Luminous Emittance – suspended luminaire with uplight

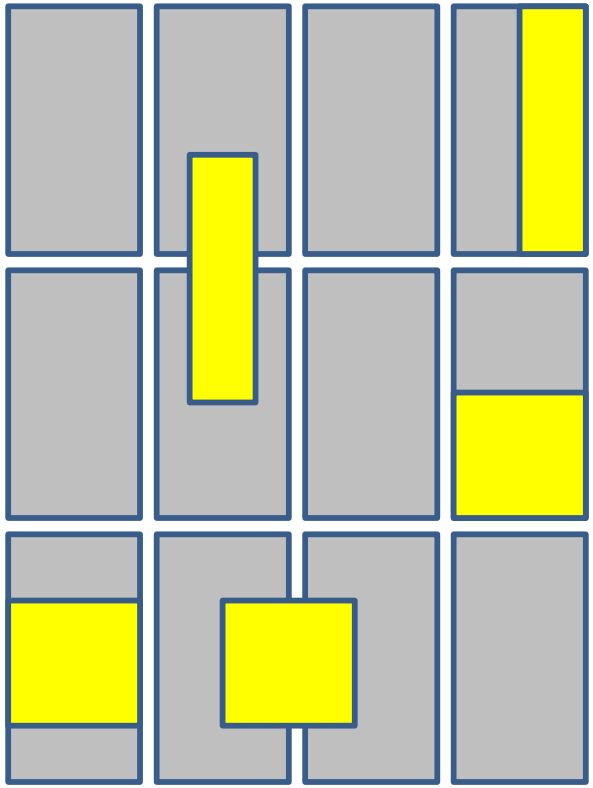


Luminous Emittance – Emergency Luminaire (corridor optics)



Selection of suitable luminaires

- Selection of proper mounting type – recessed mounting

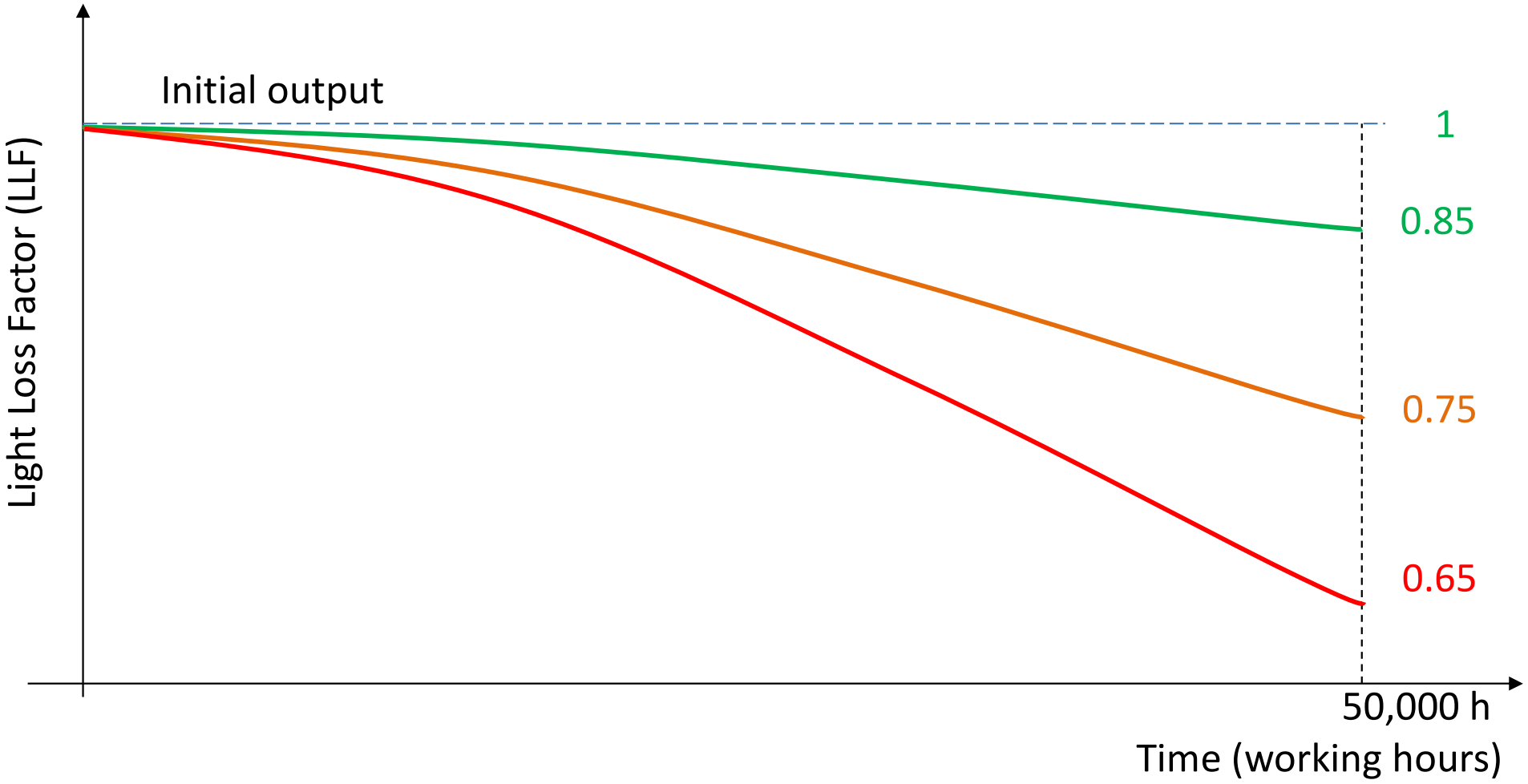


Ceiling modulation 1200mm x 600mm

Ingress Protection
(important for labs, outdoor spaces)

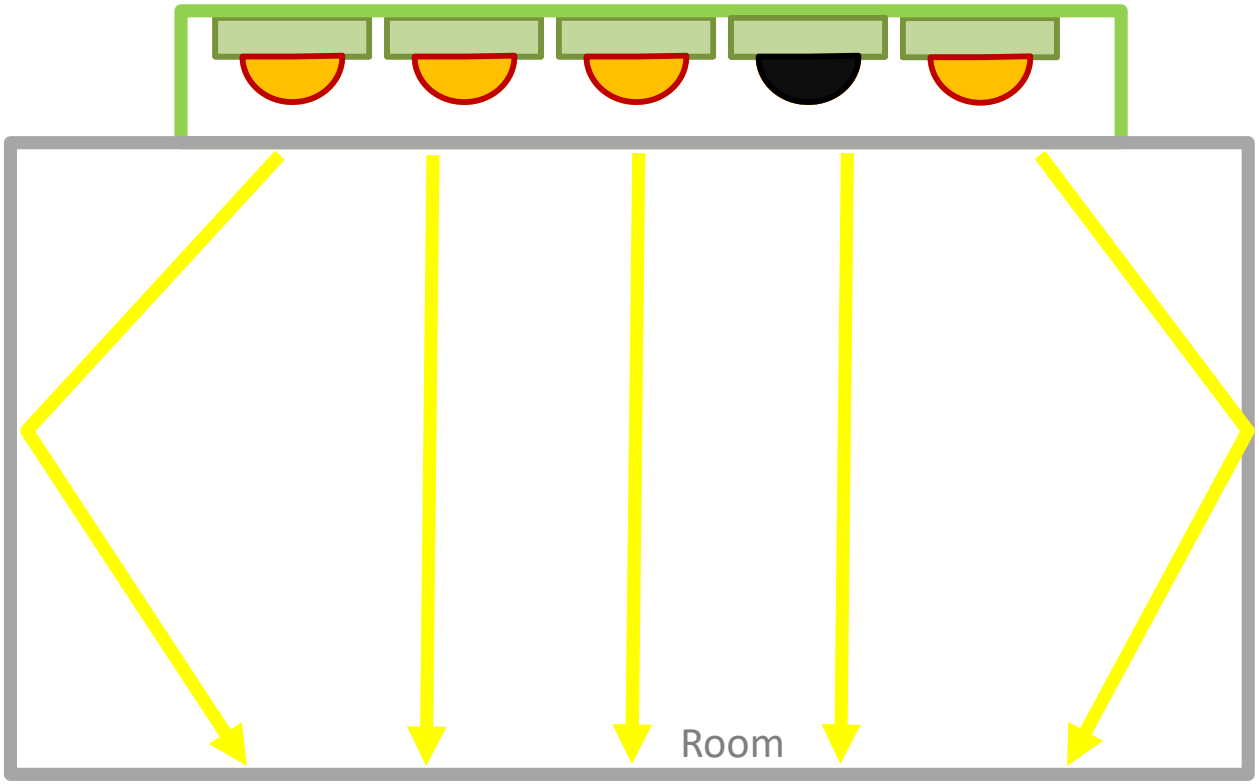
First Digit (protection from solid objects) - range from 0 to 6
Second Digit (moisture protection) - range from 0 to 8

Light loss factor (due to aging)



Light Loss Factor = LLMF x LMF x LSF x RSMF

Understanding Light Loss Factor



- Lamp Lumen Maintenance Factor (LLMF)
- Luminaire Maintenance Factor (LMF)
- Room Surface Maintenance Factor (LMF)
- Lamp Survival (LSF)

Lamp Lumen Maintenance Factor (LLMF)

U3911/LEDN221D

IP 20 | 650 °C

Recessed luminaire with Shielded Lens optics.

light source: LED • 4000 K • CRI (Ra) 80

optics: Shielded lens • polycarbonate (PC) with aluminium thin film • medium wide-angle

UGR classification: <= 16

luminous flux: 2050 lm

luminous efficacy: 138 lm/W

LLMF: 98% @ 50khrs (Tq=25°C)

LLMF = 0.98

Luminaire Maintenance Factor (LMF) – Confirmation from manufacturer

ETAP EXCELLENT LIGHTING, SAVING ENERGY

DECLARATION

TO WHOM IT MAY CONCERN

Malle, 22nd September 2014

Dear sir/madam,

Based on the report issued by TNO (https://www.tno.nl/) under the authority of ETAP LIGHTING – ZUMTOBEL STAFF – PHILIPS LIGHTING and OSRAM for the sake of having a reliable determination of the maintenance factors with respect to the EN12464 (The European Norm for lighting working spaces), the reported values authorize ETAP LIGHTING to adopt a luminaire maintenance factor of 0,95 for direct lighting luminaires in a low to medium polluted environment.

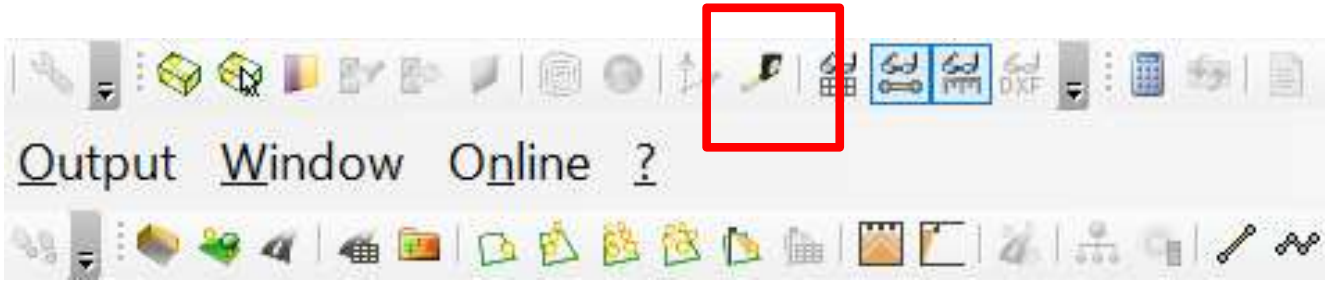
Attached TNO-report 2004-GGI-R027.

Yours sincerely,

Wim Sliepenbeek
International Sales Director ETAP Lighting

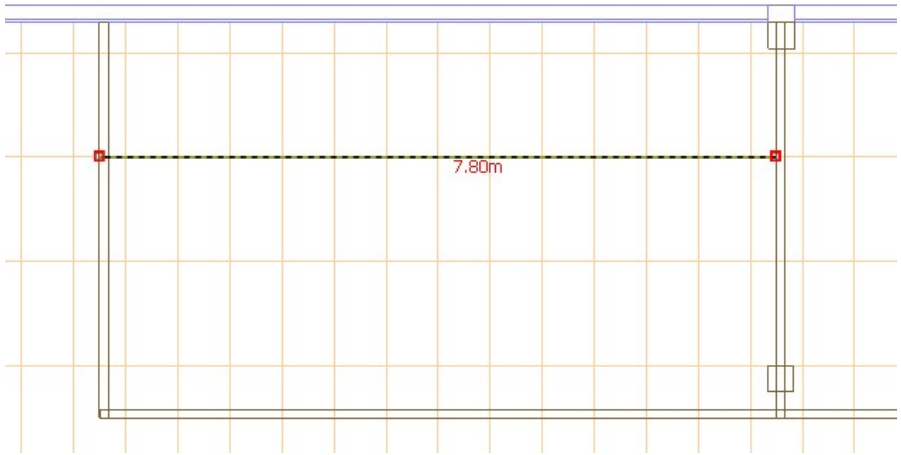
ETAP

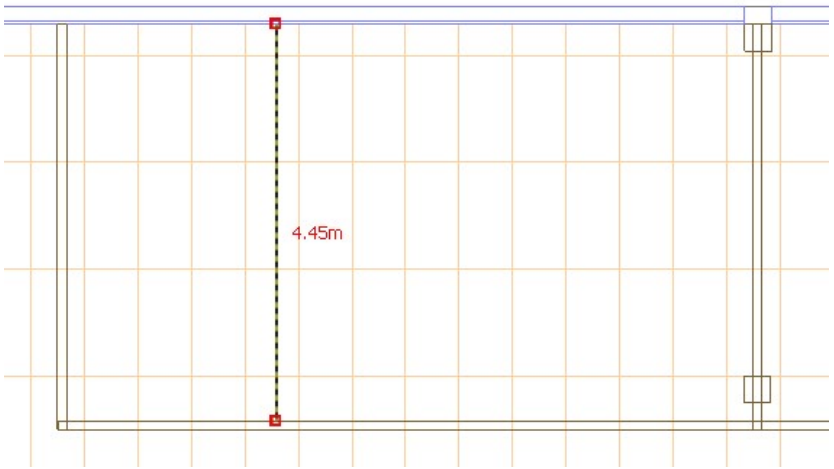
Room Index



$$RI = \frac{L \times W}{L + W} \div (H - h)$$

$$RI = \frac{7.8 \times 4.45}{7.8 + 4.45} \div (2.7 - 0.7) = \frac{34.71}{12.25} \div 2 = 1.42$$





Room Surface Maintenance Factor (RSMF) – AS/NZS 1680.4 Table B3

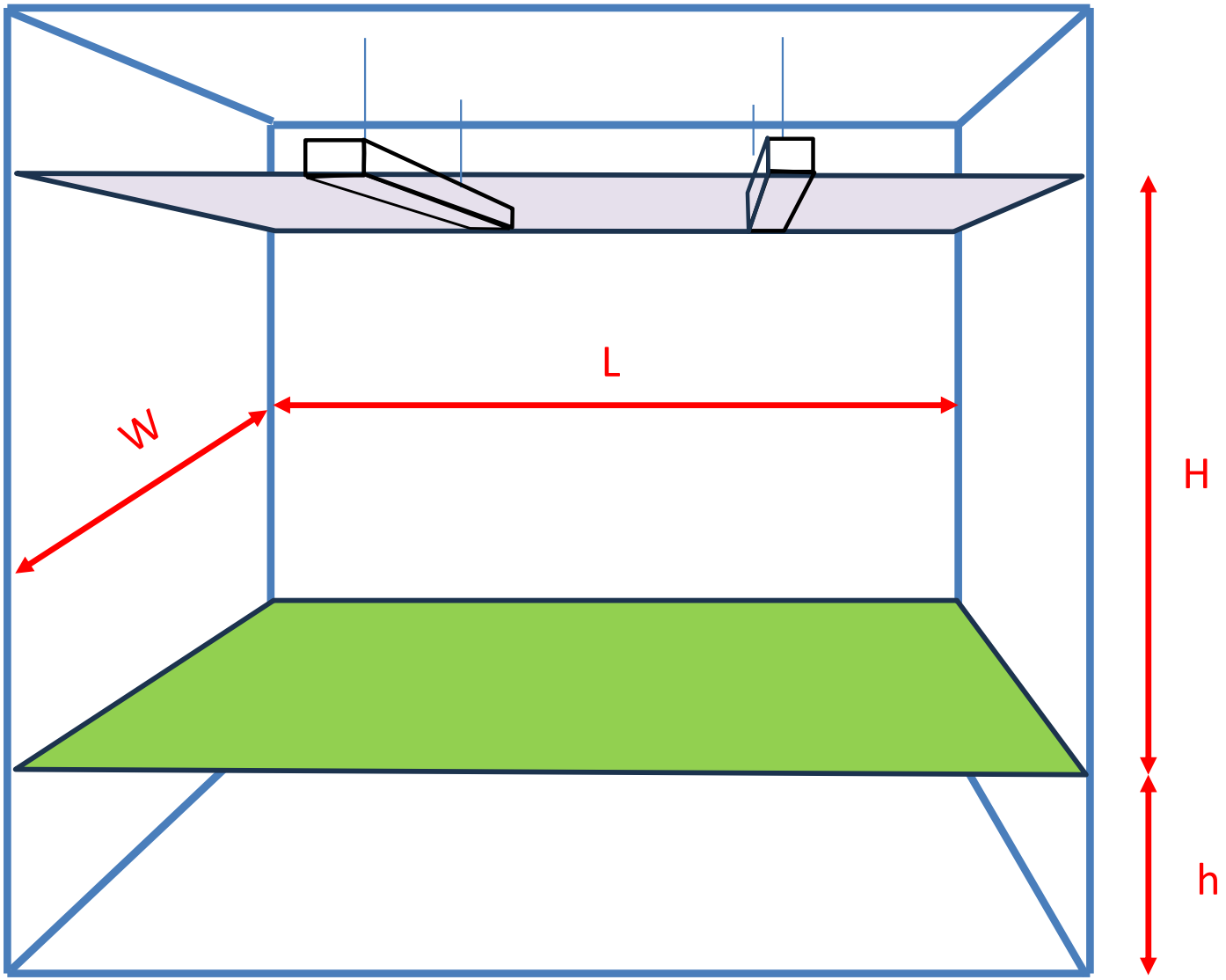
	Cleaning surfaces Every year			Cleaning surfaces two years			Cleaning surfaces three years		
Room Index	Clean	Normal	Dirty	Clean	Normal	Dirty	Clean	Normal	Dirty
Small Room *RI* = 0.7	0.97	0.94	0.93	0.95	0.93	0.9	0.94	0.92	0.88
Medium *RI*=2.5	0.98	0.96	0.95	0.96	0.95	0.94	0.96	0.95	0.94
Large Room *RI*=5	0.98	0.96	0.95	0.96	0.95	0.94	0.96	0.95	0.94

LLMF = 0.94

Examples of room index values

Room Length L (m)	Room Width W (m)	Luminaire Installation Height H (m)	Calculation Surface Height h (m)	Room index (m)
3	3	2.7	0.7	0.75
5	5	2.7	0.7	1.25
10	10	2.7	0.7	2.50
20	20	3	0.7	4.35
25	25	3	0.7	5.43

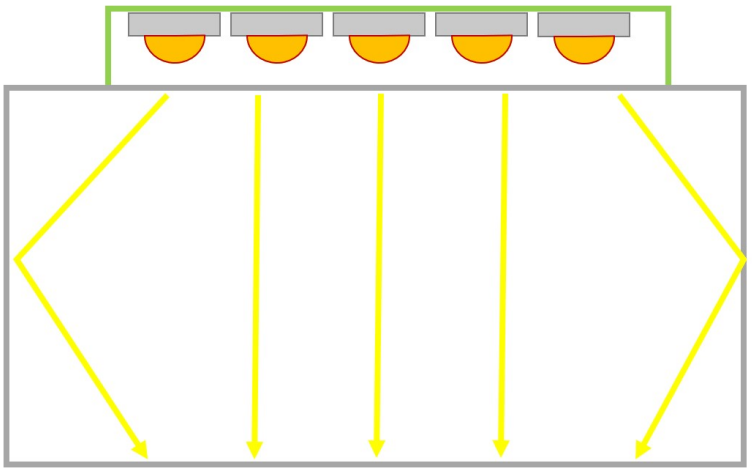
Understanding dimensions



Calculating Light Loss Factor at 50khs

$$LLF = LLMF \times LMF \times LSF \times RSMF$$

$$LLF = 0.98 \times 0.95 \times 1 \times 0.94 = 0.875 \approx 0.88$$



LLMF – Lamp lumen maintenance factor

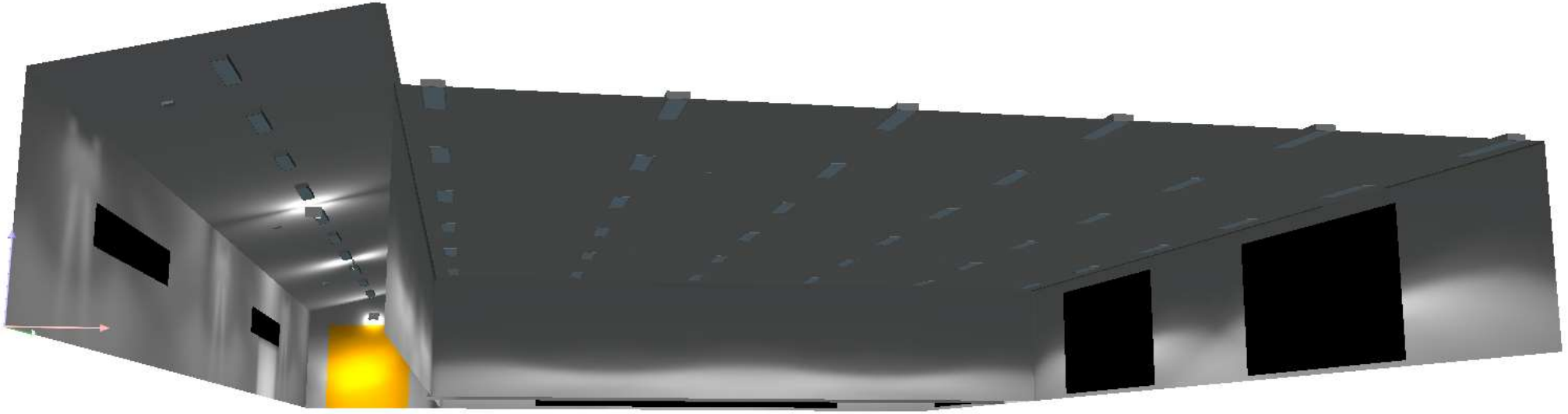
LMF – Luminaire maintenance factor

LSF – Lamp survival factor

RSMF – Room surface maintenance factor

Emergency Lighting

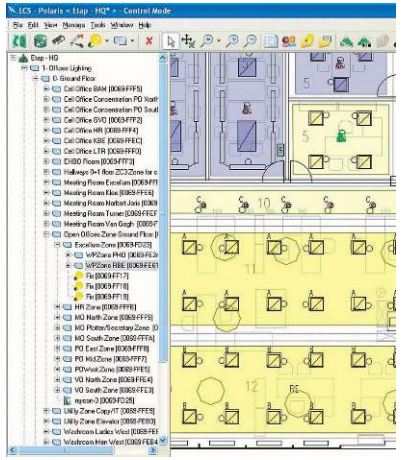
Lighting



Emergency Lighting

Standard and Regulations

- Lighting: compliant for each internal usage area with AS/NZS 1680.



- Emergency lighting: New Zealand building code clause F6 and F8, and AS/NZS 2293.