

FAGERHULT

Les Thomas MSL

# Lighting for Education



# SCHOOL TIME TABLE

**MONDAY**

Lighting Design  
And  
Guides

**TUESDAY**

Emergency  
Lighting

**WEDNESDAY**

Island's  
of  
Light

**THURSDAY**

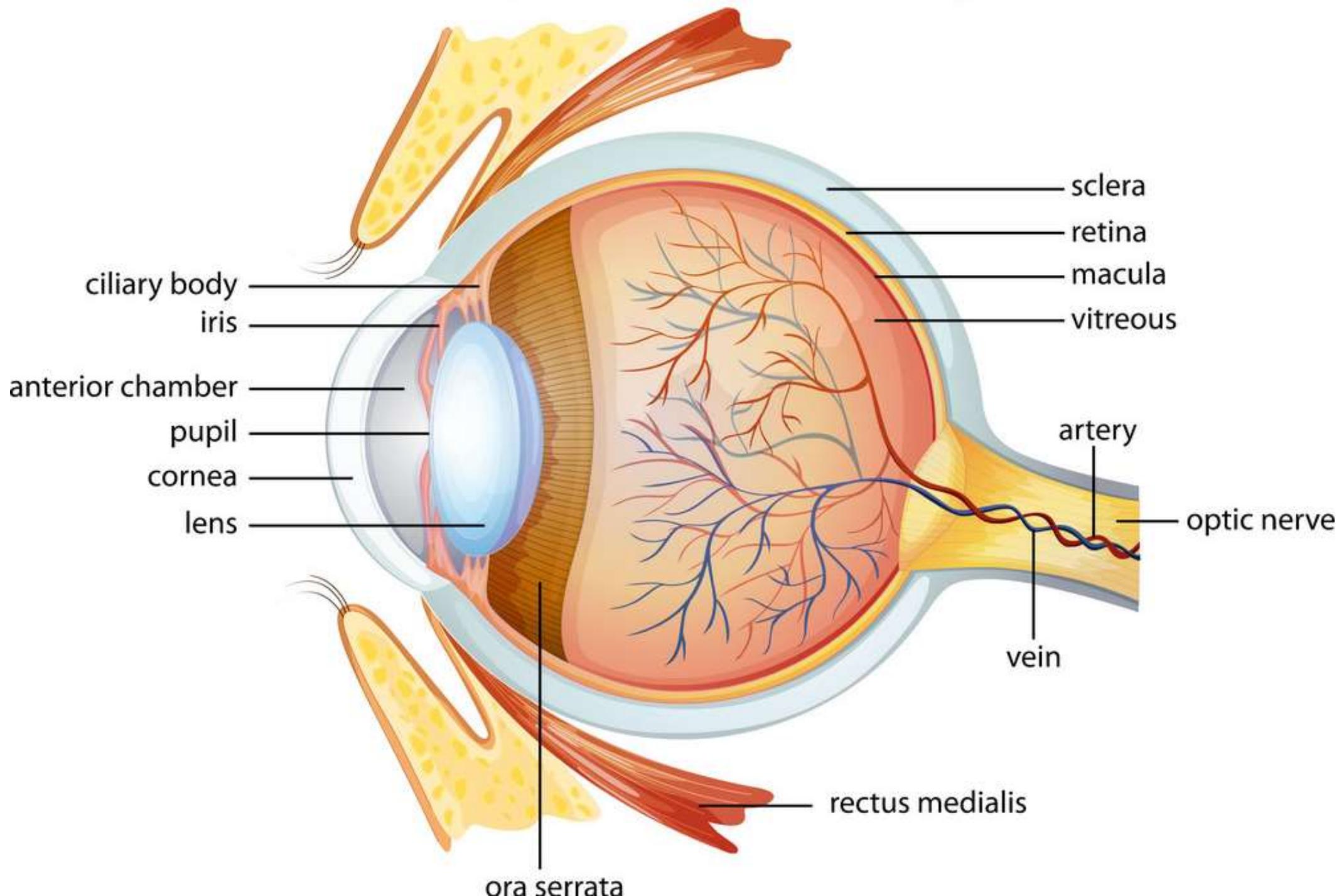
Circadian  
Lighting

**FRIDAY**

Lighting  
Controls







THE RIGHT LIGHT

IN THE RIGHT PLACE

AT THE RIGHT TIME





# Lighting Guide 5: Lighting for education

BS EN 12464-1:2011



BSI Standards Publication

## Light and lighting — Lighting of work places Part 1: Indoor work places



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**bsi.**

...making excellence a habit.™



**Classrooms**

Ceiling

$E_h =$   
50lux

Walls

$E_v =$   
100lux

$E_z = 150\text{lux}$   
10%  $U_o$

$UGR < 19$

Task  
300lux,  
60%  $U_o$

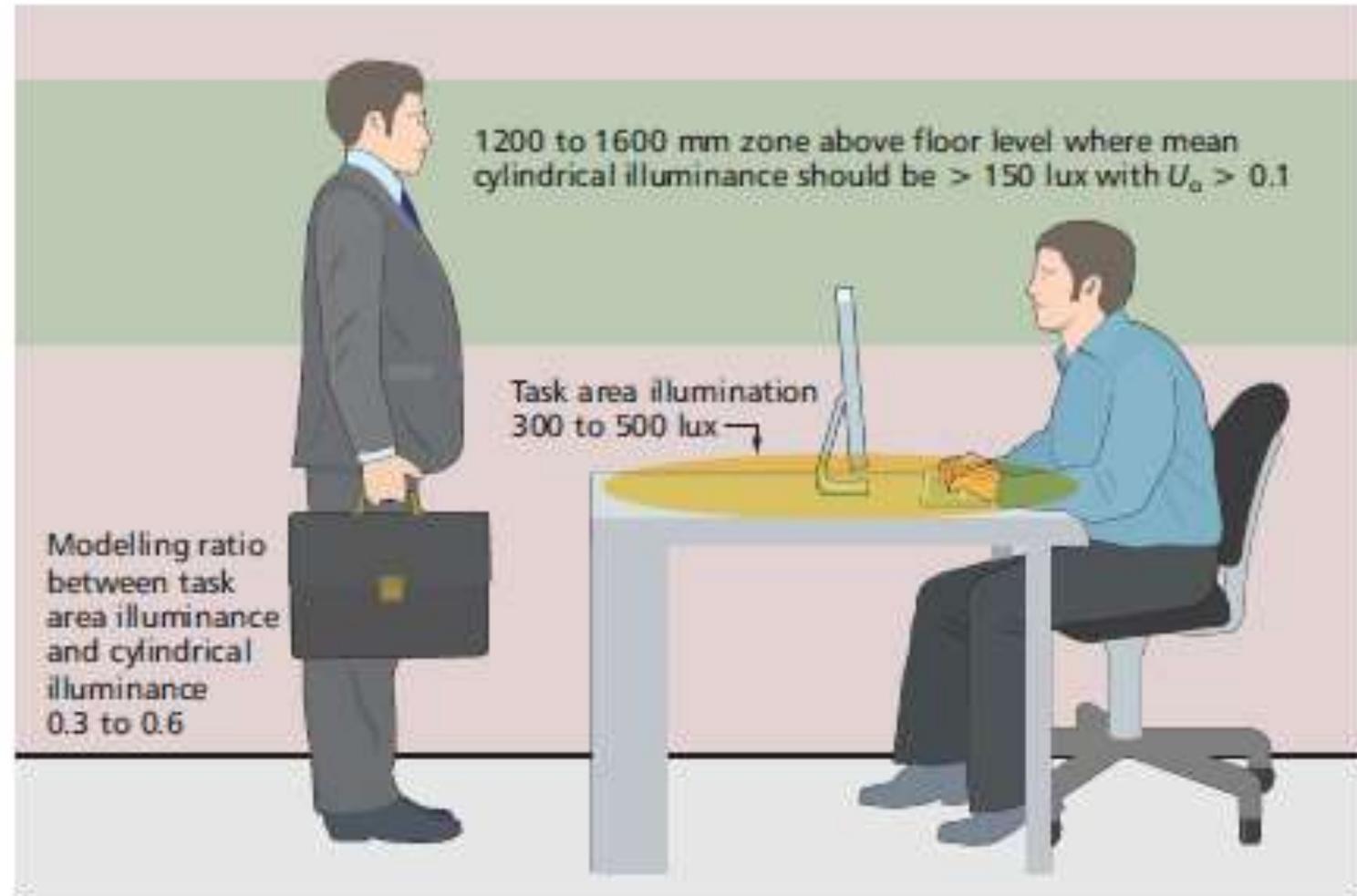
$E_z = 150 \text{ lux}$   
10%  $U_0$

# Cylindrical Illuminance

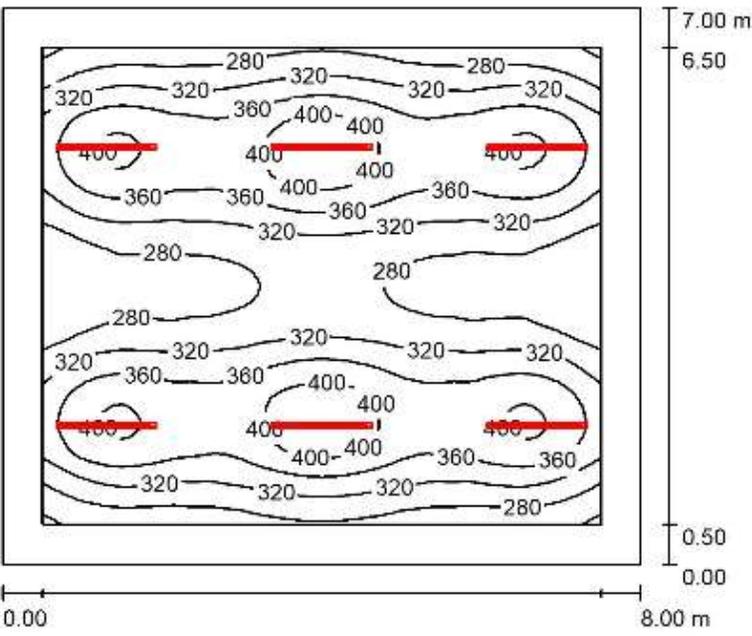


# Cylindrical Illuminance

Figure 2.1 Application of cylindrical illuminance



# Cylindrical Illuminance



332 lux

70.2%

Height of Room: 3.200 m, Mounting Height: 2.700 m, Maintenance factor: 0.80

Values in Lux, Scale 1:90

Surface	$\rho$ [%]	$E_{av}$ [lx]	$E_{min}$ [lx]	$E_{max}$ [lx]	u
Workplane	/	332	233	431	0.702
Floor	20	279	170	338	0.630
Ceiling	70	299	55	2136	0.185
Walls (4)	50	140	76	279	/

**Workplane:**

Height:	0.750 m	<b>UGR</b>	Lengthways-	Across	to luminaire axis
Grid:	64 x 64 Points	Left Wall	14	15	
Boundary Zone:	0.500 m	Lower Wall	14	14	
		(CIE, SHR = 1.00.)			

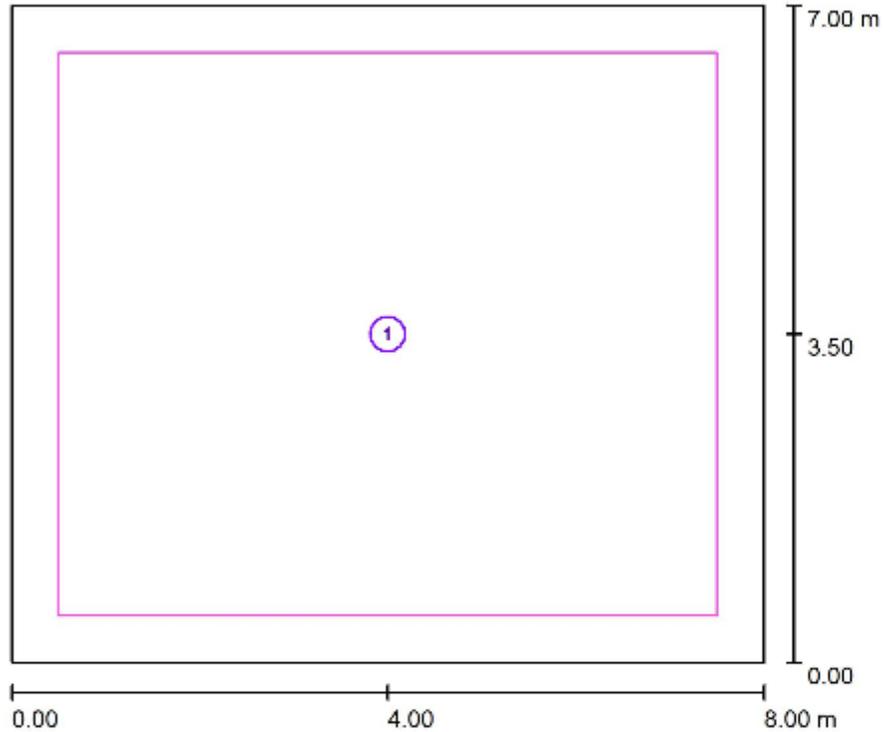
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.418, Ceiling / Working Plane: 0.901.

**Luminaire Parts List**

No.	Pieces	Designation (Correction Factor)	$\Phi$ (Luminaire) [lm]	$\Phi$ (Lamps) [lm]	P [W]
1	6	FAGERHULT 13387-402 Notor 65 Delta Dir-ind 1200 start HL white 4K 1xLED 43 W (1.000)	5000	5000	43.0
			Total: 30000	Total: 30000	258.0

Specific connected load: 4.61 W/m<sup>2</sup> = 1.39 W/m<sup>2</sup>/100 lx (Ground area: 56.00 m<sup>2</sup>)

# Cylindrical Illuminance



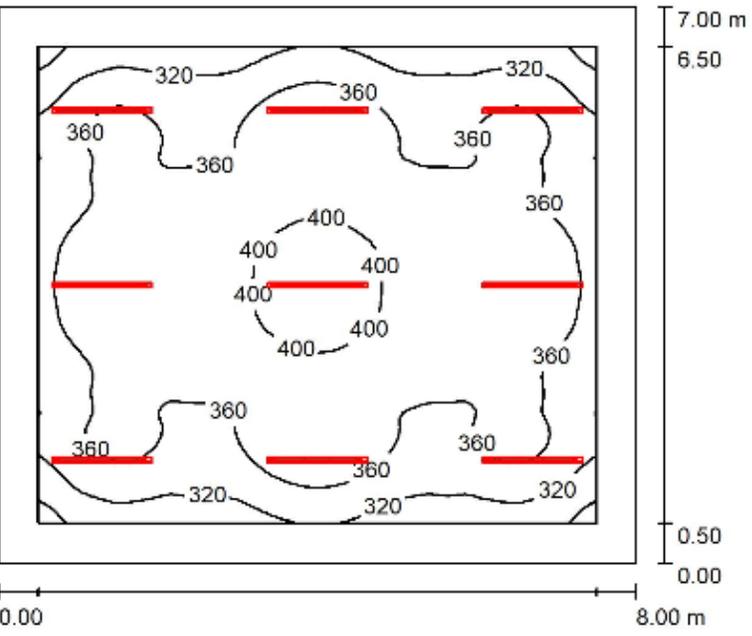
136 lux

Scale 1 : 80

## Calculation Surface List

No.	Designation	Type	Grid	$E_{av}$ [lx]	$E_{min}$ [lx]	$E_{max}$ [lx]	u0	$E_{min} / E_{max}$
1	Calculation Surface 1	cyl.	32 x 32	136	118	154	0.870	0.768

# Cylindrical Illuminance



361 lux

74%

Height of Room: 3.200 m, Mounting Height: 2.700 m, Maintenance factor: 0.80

Values in Lux, Scale 1:90

Surface	$\rho$ [%]	$E_{av}$ [lx]	$E_{min}$ [lx]	$E_{max}$ [lx]	$u0$
Workplane	/	361	267	427	0.740
Floor	20	237	189	371	0.833
Ceiling	70	335	70	1628	0.210
Walls (4)	50	158	94	232	/

**Workplane:**

Height:	0.750 m	UGR	Lengthways-	Across	to luminaire axis
Grid:	64 x 64 Points	Left Wall	13	13	
Boundary Zone:	0.500 m	Lower Wall	13	13	
		(CIE, SHR = 1.00.)			

Illuminance Quotient (according to LG7): Walls / Working Plane: 0.439, Ceiling / Working Plane: 0.929.

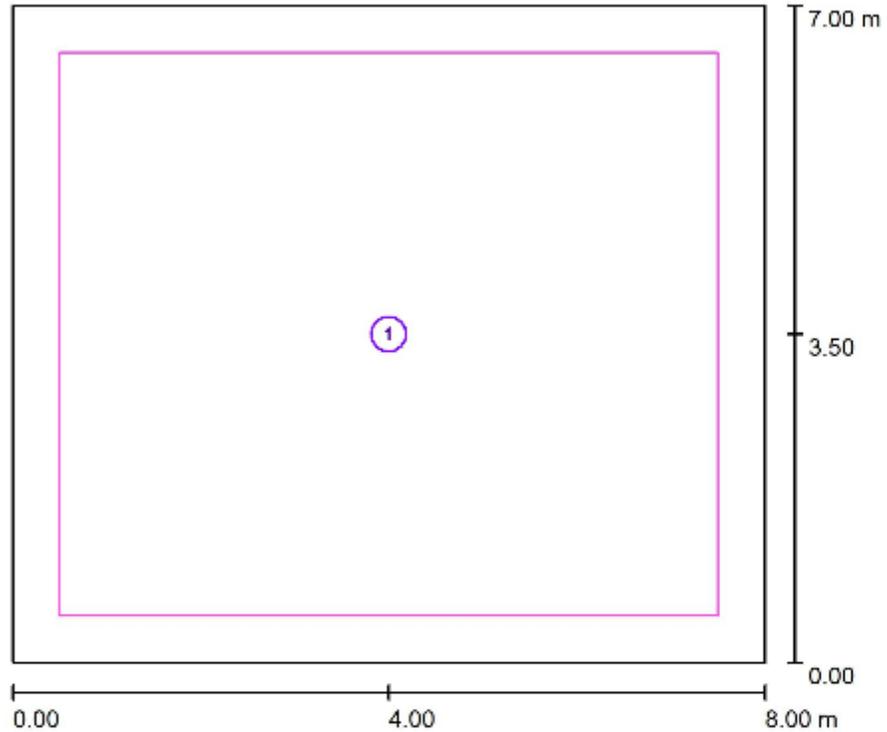
**Luminaire Parts List**

No.	Pieces	Designation (Correction Factor)	$\Phi$ (Luminaire) [lm]	$\Phi$ (Lamps) [lm]	P [W]
1	9	FAGERHULT 13386-402 Notor 65 Delta Dir-ind 1200 start LL white 4K 1xLED 30 W (Type 1)* (1.000)	3710	3710	31.8

\*Modified Technical Specifications Total: 33390      Total: 33390      286.2

Specific connected load: 5.11 W/m<sup>2</sup> = 1.42 W/m<sup>2</sup>/100 lx (Ground area: 56.00 m<sup>2</sup>)

# Cylindrical Illuminance



150 lux

Scale 1 : 80

## Calculation Surface List

No.	Designation	Type	Grid	$E_{av}$ [lx]	$E_{min}$ [lx]	$E_{max}$ [lx]	$u0$	$E_{min} / E_{max}$
1	Calculation Surface 1	cyl.	32 x 32	150	128	169	0.856	0.758

# Modelling Index



(a) Modelling index = 0.1; highly directional downlight creates harsh shadows



(d) Modelling index = 1.0; except for theatre lighting, it is difficult to get an index much greater than 1.0 and values higher than this would provide modelling of the face making it difficult to lip read, for example

# Modelling Index



(b) Modelling index = 0.3; the limit of acceptable modelling in spaces where good communication is required and still too harsh for some children with special educational needs



(c) Modelling index = 0.5; more appropriate for children's classrooms

Ceiling

$E_h =$   
50lux

Walls

$E_v =$   
100lux

$E_z = 150\text{lux}$   
10%  $U_o$

$UGR < 19$

Task  
500lux,  
60%  $U_o$

Lecture

Theatres

# Lecture Theatres

Ceiling  
 $E_h =$   
50 lux

Audience  
300–500  
lux

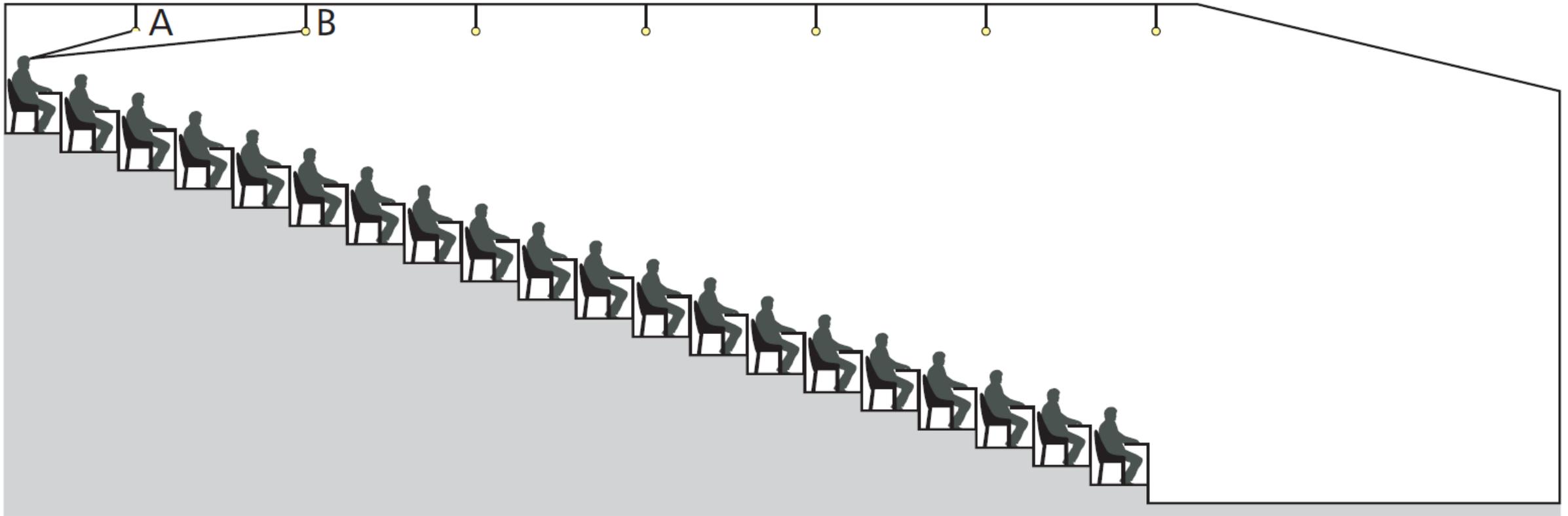
Walls  
 $E_v =$   
100 lux

$E_z = 150$  lux  
10%  $U_0$

UGR < 19

Lecturer  
500–750  
lux





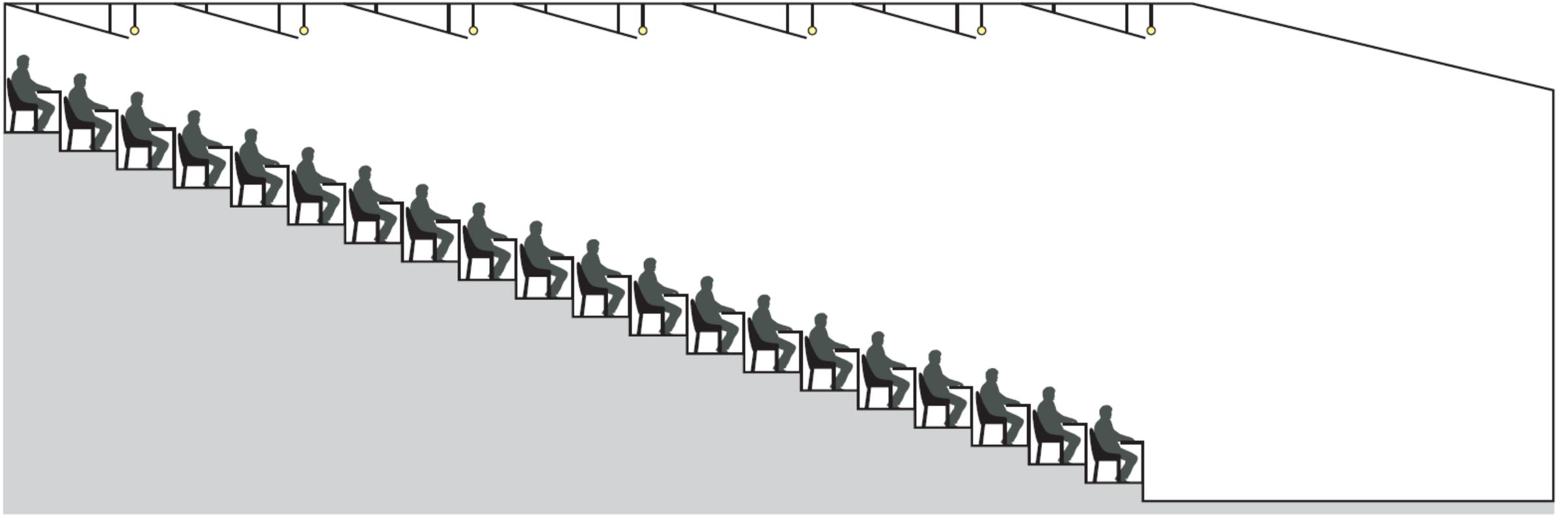
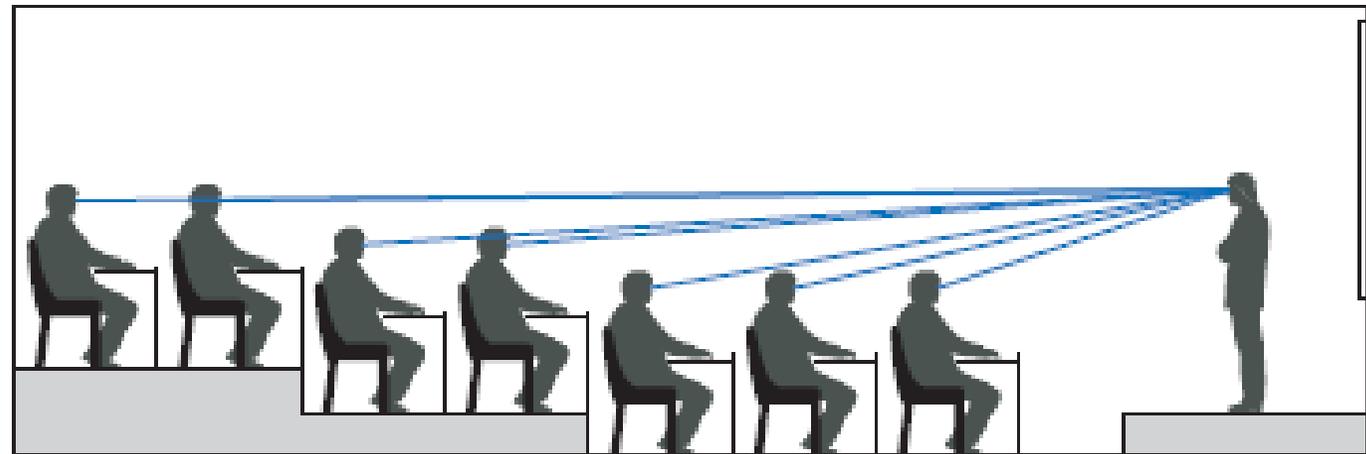
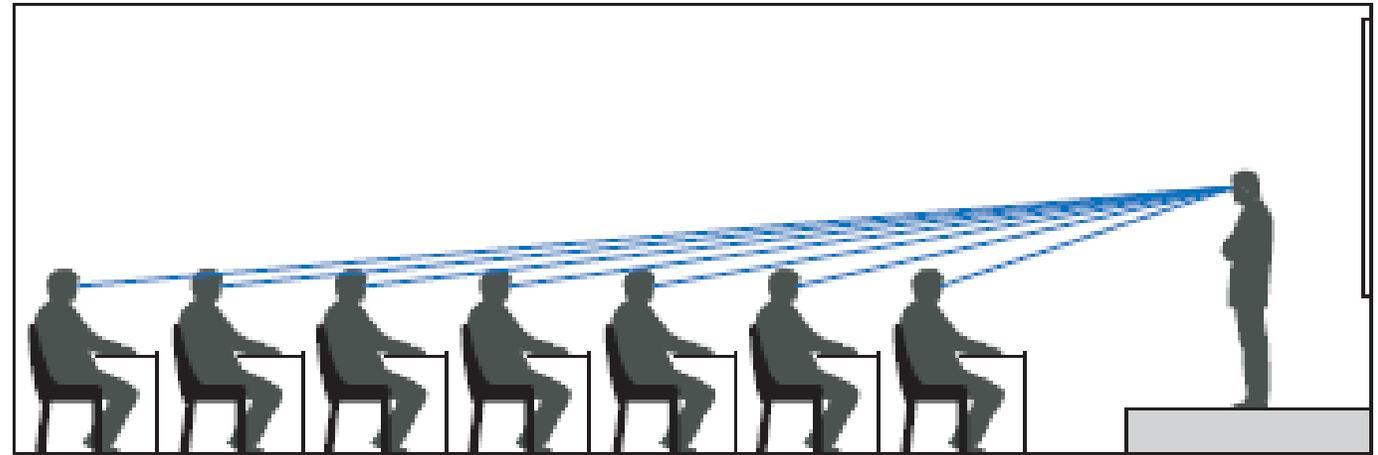
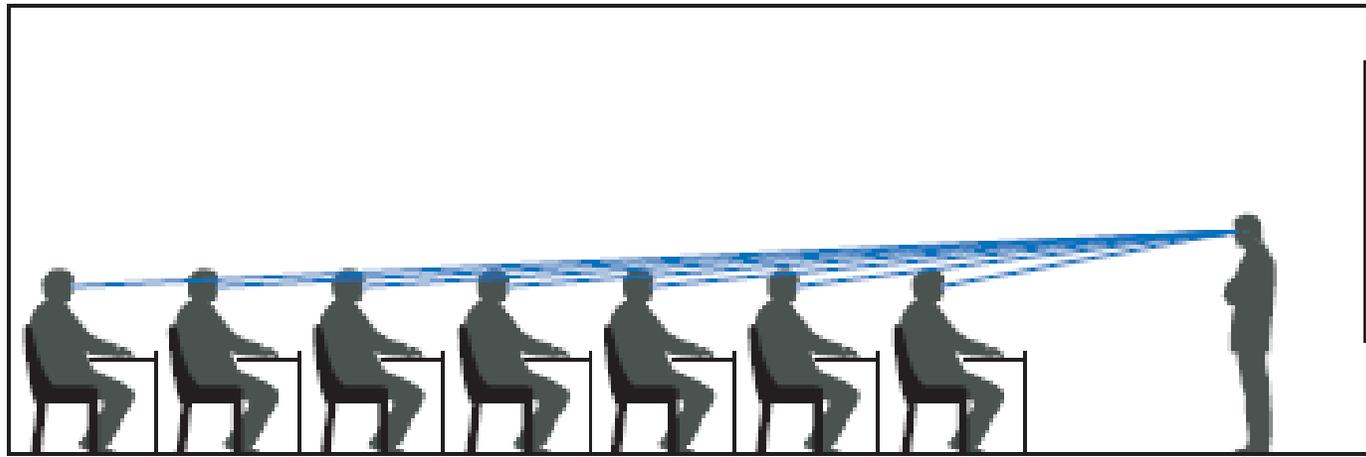
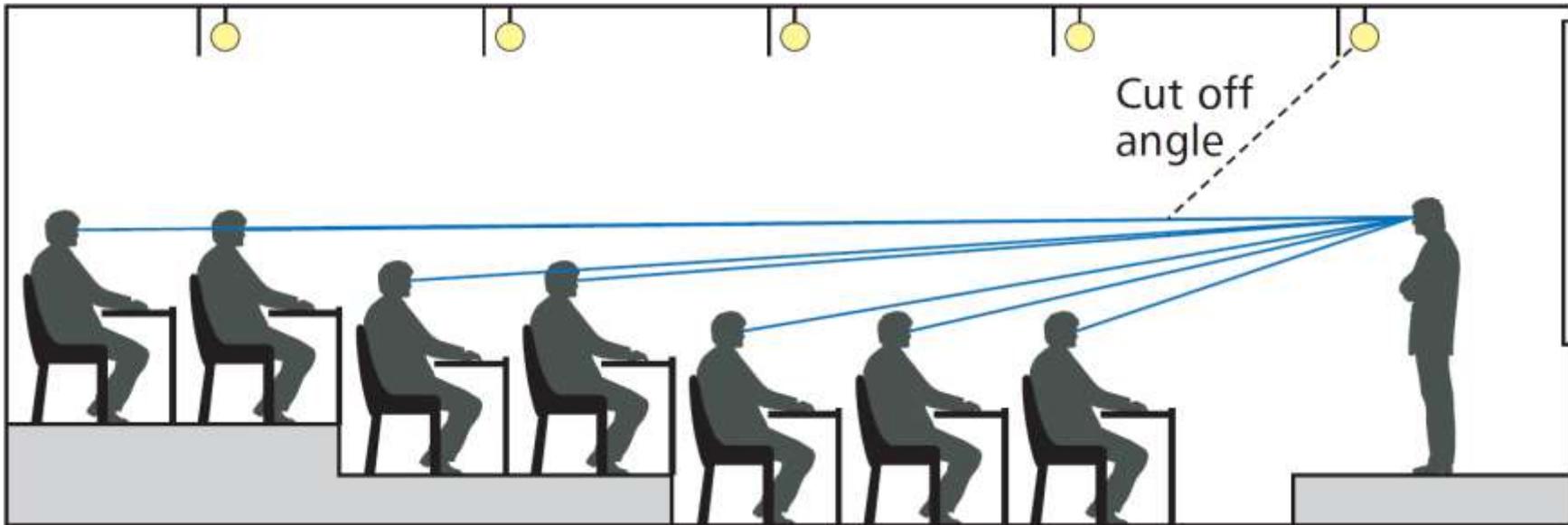
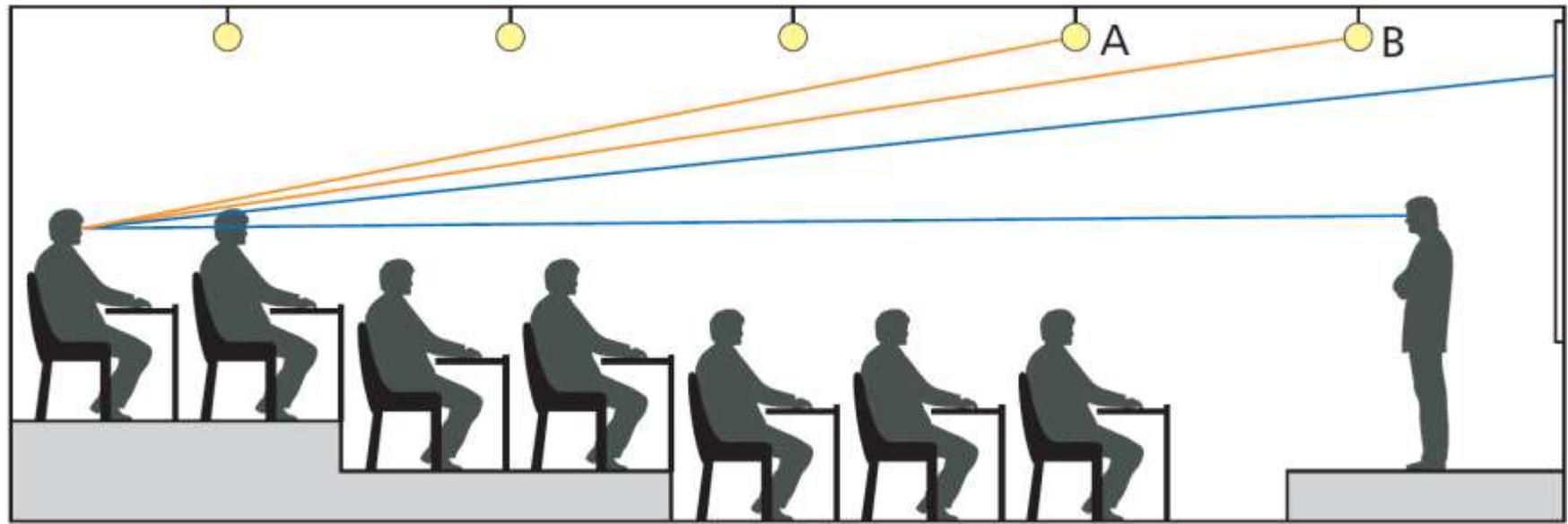




Image Ref: St Anthony's College - LED Linear/Luke Hayes







## 2<sup>nd</sup> year Biochemistry

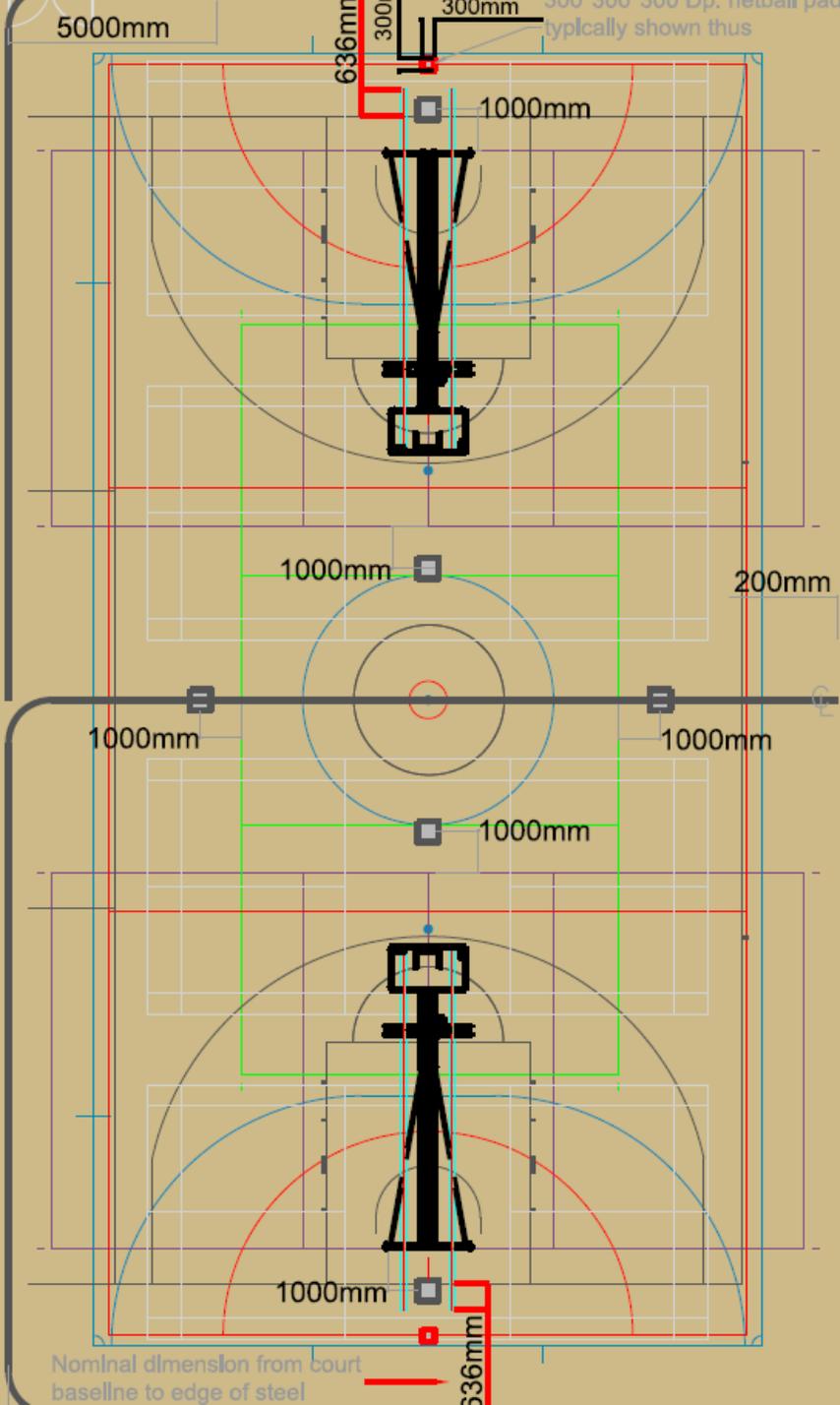
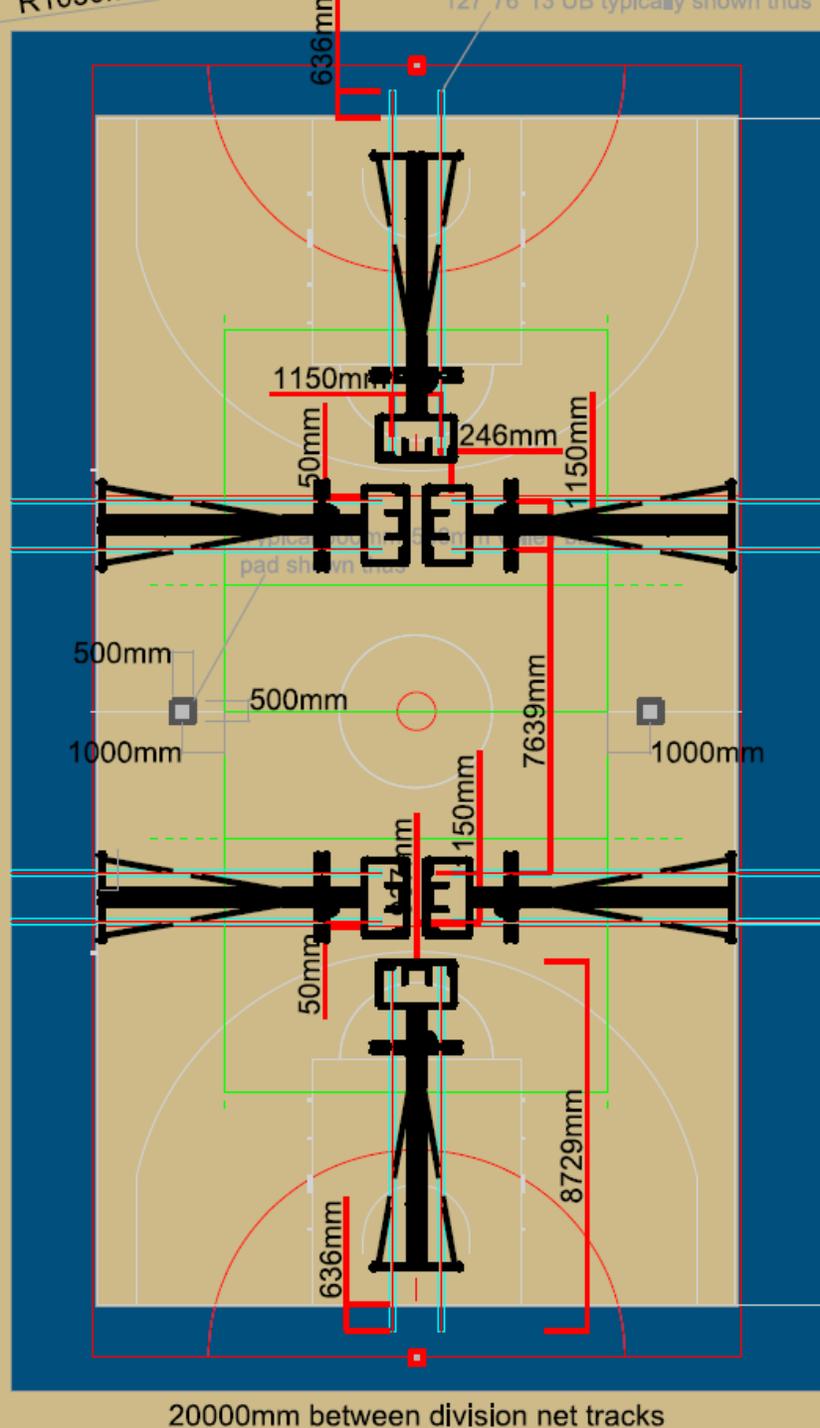
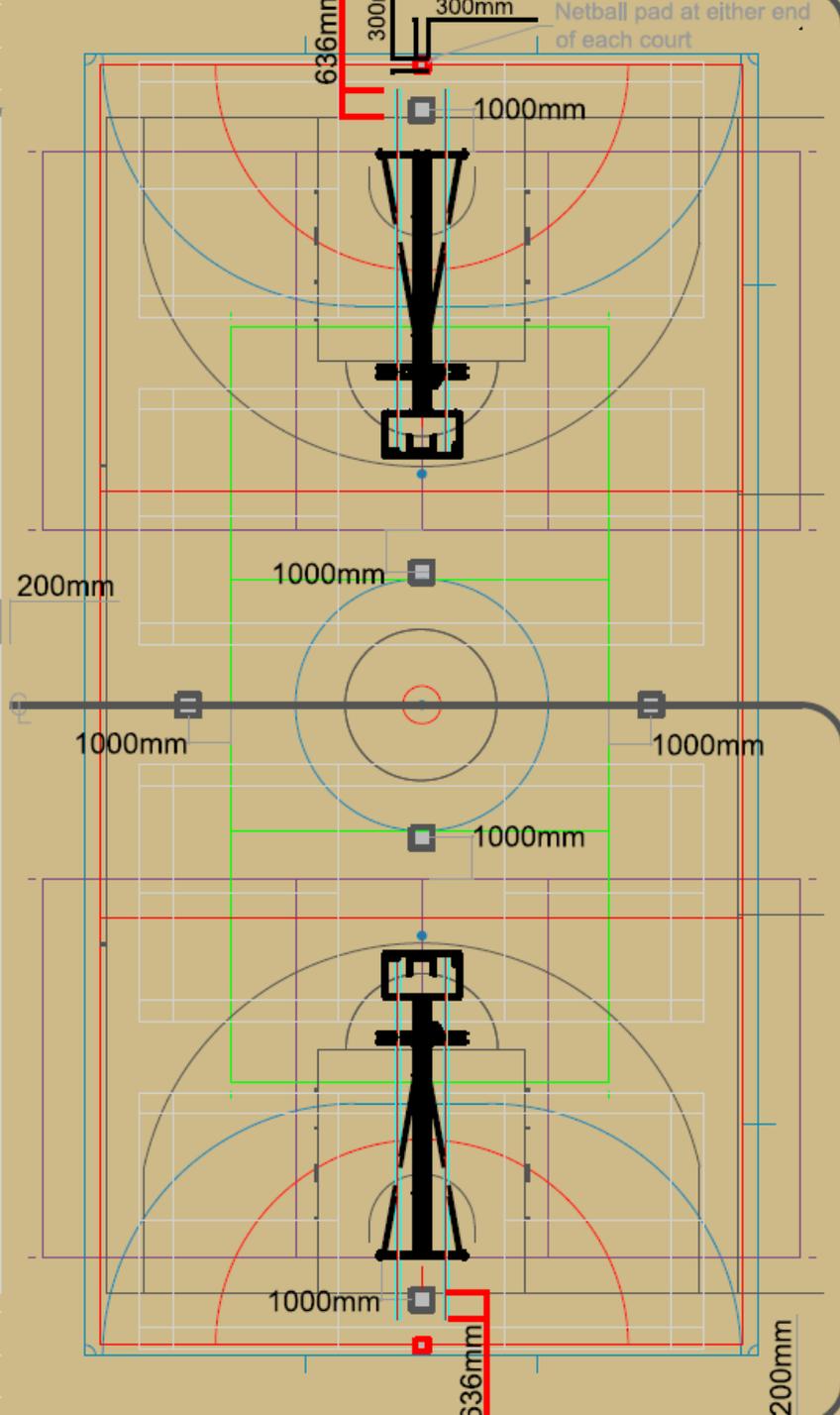
- Biochemistry is a key discipline in modern biological research
- It addresses key areas of biology, including molecular biology, cell biology, genetics, structural biology, biomedicine, and pharmacology
- Progress in biomedical and pharmaceutical areas is dependent on good biochemical understanding

**Sports**

**Halls**

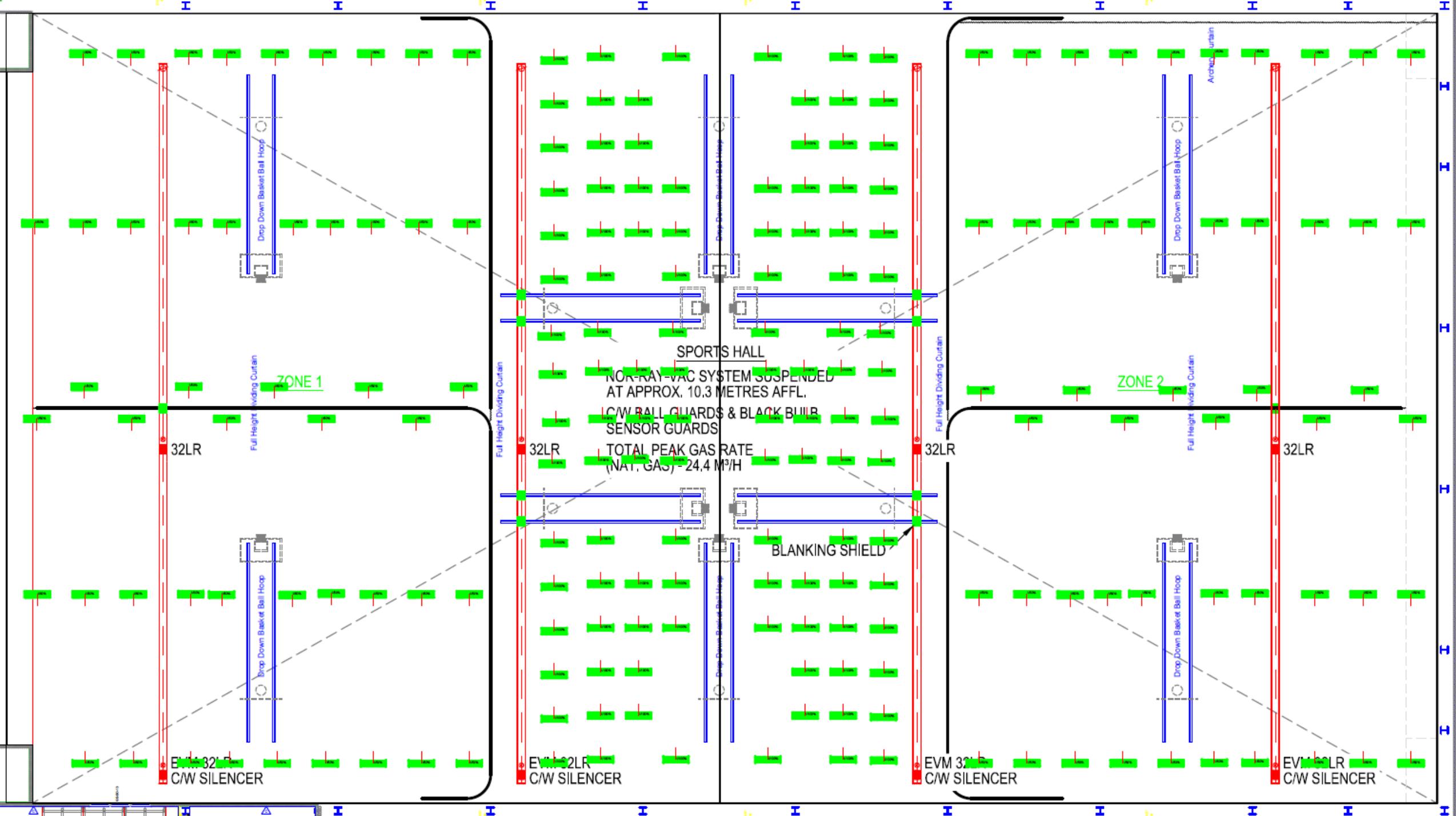
300 -  
1000lux  
, 70%  
Uo





20000mm between division net tracks

Nominal dimension from court baseline to edge of steel



SPORTS HALL

NOR-RAY-VAC SYSTEM SUSPENDED  
AT APPROX. 10.3 METRES AFLL.

C/W BALL GUARDS & BLACK BULB  
SENSOR GUARDS

TOTAL PEAK GAS RATE  
(NAT. GAS) = 24.4 M<sup>3</sup>/H

BLANKING SHIELD

ZONE 1

ZONE 2

32LR

32LR

32LR

32LR

EVM 32LR  
C/W SILENCER

EVM 32LR  
C/W SILENCER

EVM 32LR  
C/W SILENCER

EVM 32LR  
C/W SILENCER

Drop Down Basket Ball Hoop

Drop Down Basket Ball Hoop

Drop Down Basket Ball Hoop

Full Height Dividing Curtain

Full Height Dividing Curtain

Full Height Dividing Curtain

Full Height Dividing Curtain

Drop Down Basket Ball Hoop

Drop Down Basket Ball Hoop

Drop Down Basket Ball Hoop

Architect's Curtain



VDE 0710-13





**Library**

Management, Chemical engineering  
Management, Software

660.6  
660.7  
660.8  
660.9  
661  
662  
663  
664  
665  
666  
667  
668  
669

660 - 690

Management, Management  
Engineering, Management

660.6  
660.7  
660.8  
660.9  
661  
662  
663  
664  
665  
666  
667  
668  
669

658 - 660



# Emergency Lighting

## Regulatory Reform (Fire Safety) Order 2005

emergency routes and exits must be indicated by signs; and

emergency routes and exits requiring illumination must be provided with emergency lighting of adequate intensity in the case of failure of their normal lighting.

## Regulatory Reform (Fire Safety) Order 2005

17.—(1) Where necessary in order to safeguard the safety of relevant persons the responsible person must ensure that the premises and any facilities, equipment and devices provided in respect of the premises under this Order or, subject to paragraph (6), under any other enactment, including any enactment repealed or revoked by this Order, are subject to a suitable system of maintenance and are maintained in an efficient state, in efficient working order and in good repair.



**CRIME SCENE DO NOT CROSS**

# Open Area

500

CORE AREA  
0.5 Lux Minimum  
1:40 Diversity Ratio  
(Min/Max)

# Escape Route

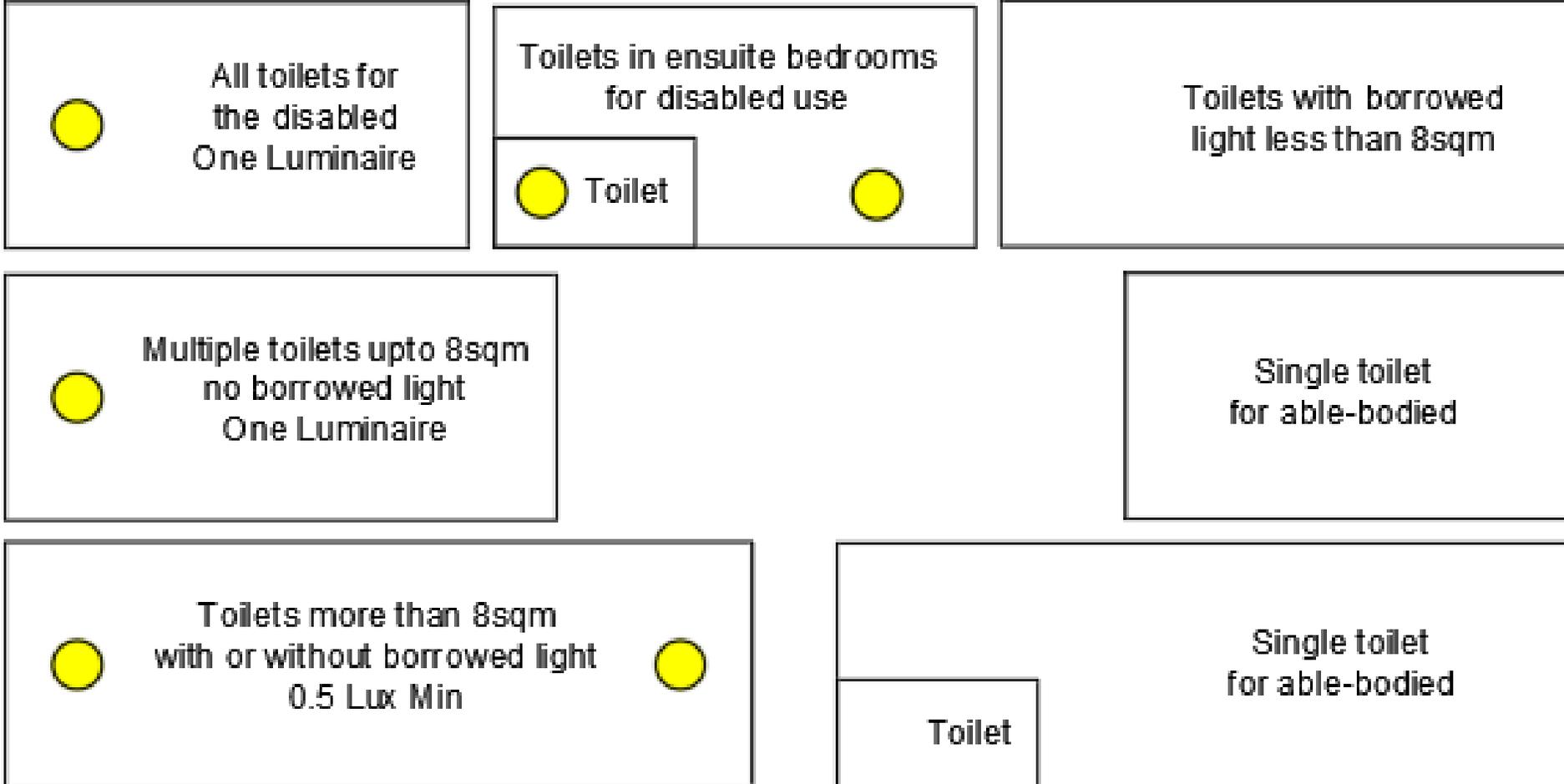
1:40 Diversity Ratio  
(Min/Max)



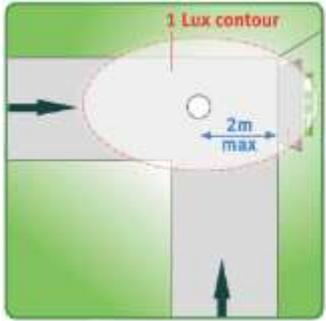
1 Lux Minimum  
on centre line

50% of central line in  
central 1m band

# Toilets



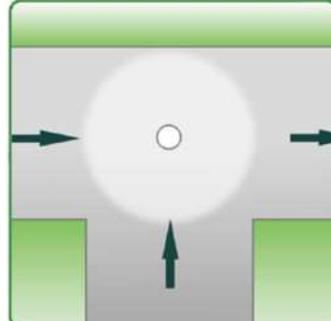
# Points of Emphasis



Near Exit  
Doors



Near change  
of level



At change  
of direction



Outside and  
near final  
exit



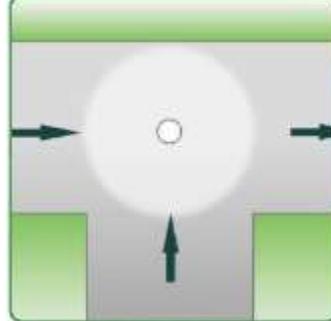
Near fire  
fighting  
equipment  
and call  
points



Nears Stairs



Nears Stairs



At  
intersection  
s



Near each  
First Aid  
point

# High Risk Areas

## **5.2.7 – High Risk task areas**

If emergency escape lighting is required to provide illumination for the safety of people involved in a potentially dangerous process or situation, and to enable proper shut-down procedures for the safety of the operator and other occupants, the illuminance value should not be less than 10% of the average of the normal lighting at the location.

BS5266-1:2016 Section 5.2.7

## **4.4 – High Risk task area lighting**

4.4.1 In areas of high risk the maintained illuminance on the task area plane shall not be less than 10% of the required maintained illuminance for that task, however, it shall not be less than 15lux....

4.4.2 The uniformity 'Uo' of the high risk task area lighting illuminance shall not be less than 0.1.



TEST



# Islands of Light



## Prototype scenario: illumination principles

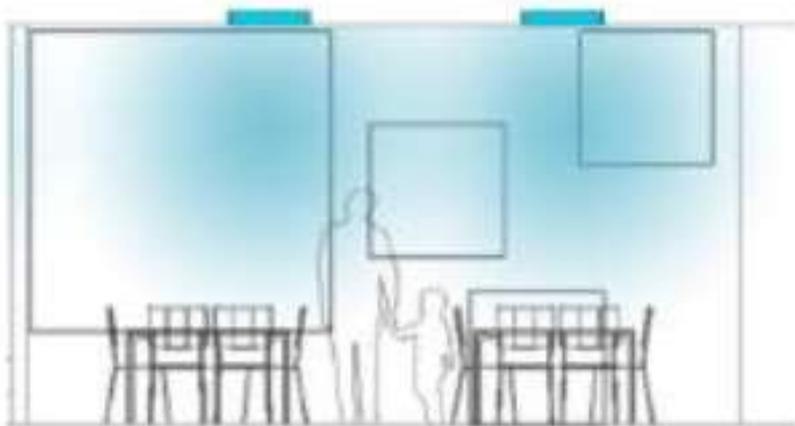


Fig.2a Ceiling lighting only

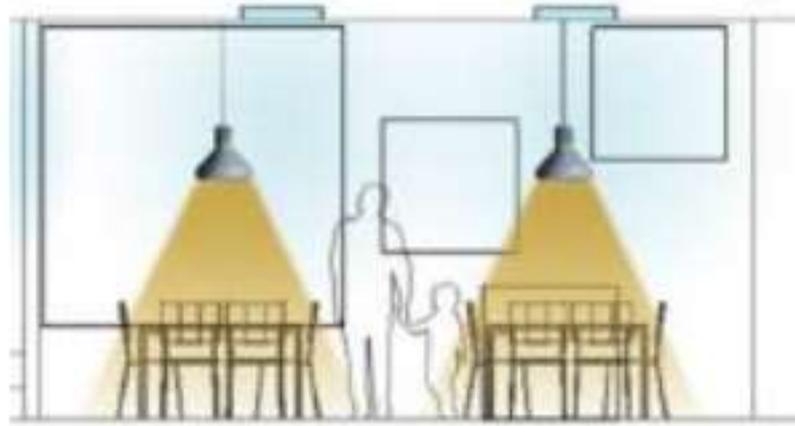


Fig.3a Ceiling + Pendants

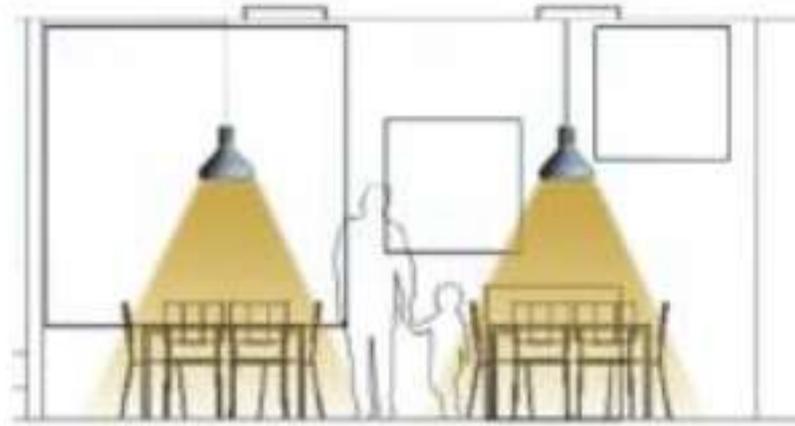


Fig.4a Pendants only

## Prototype scenario: light distribution (false color luminance maps)

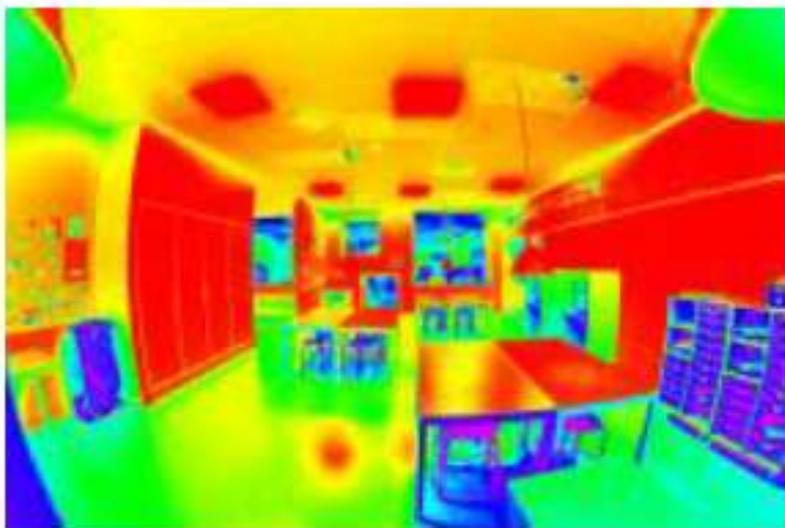


Fig.2b Ceiling lighting only

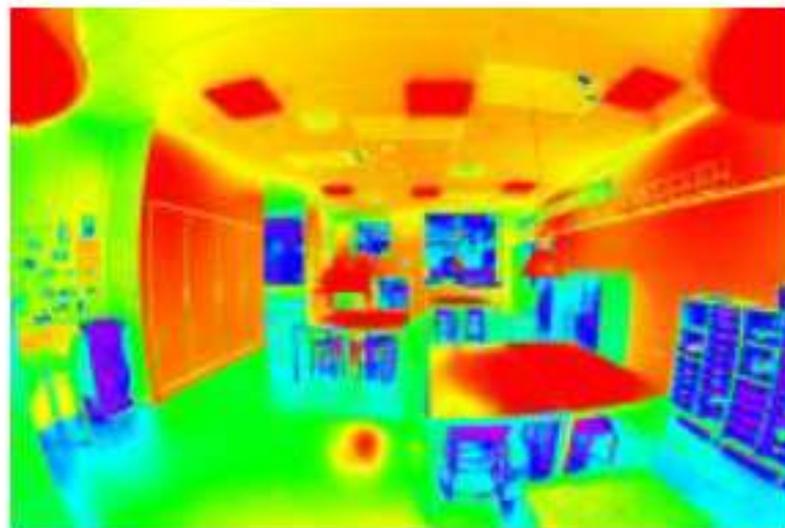


Fig.3b Ceiling + Pendants



Fig.4b Pendants only

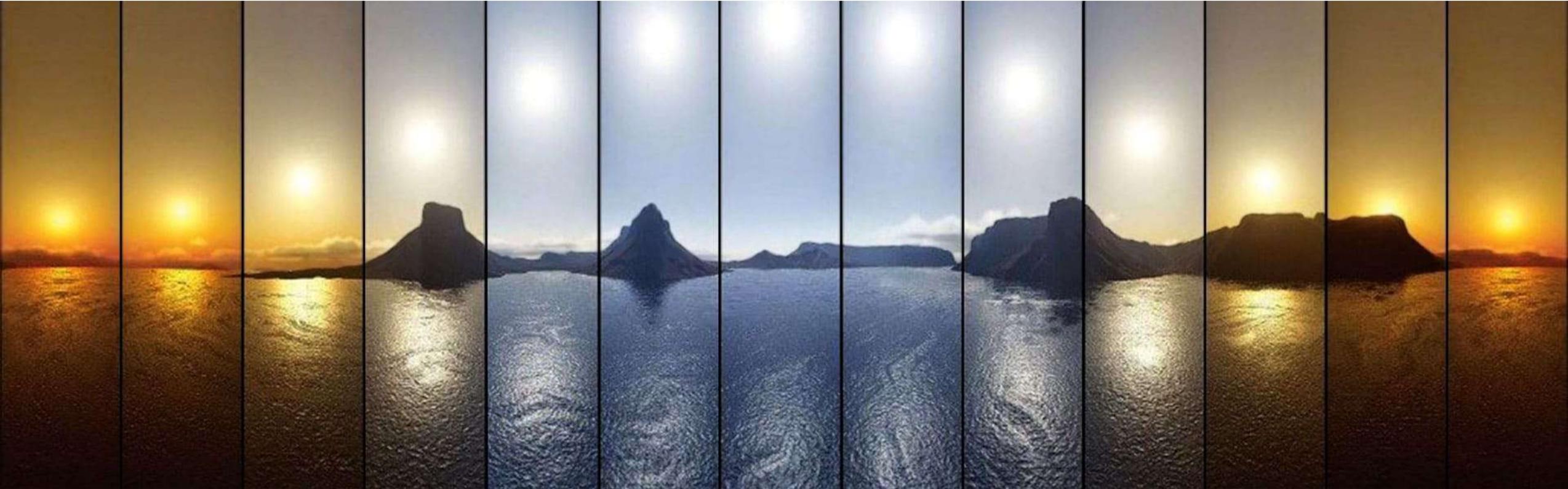


Image Ref:  
Henning Larsen Architects,  
Halfdan Trolle

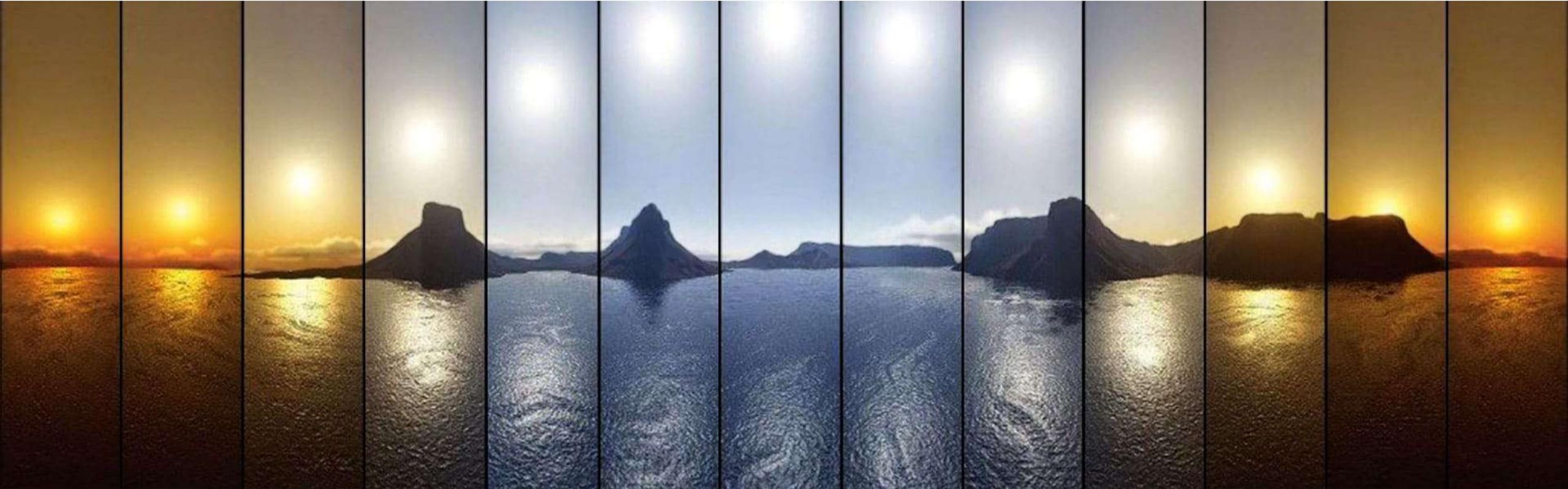


'A difference of just three decibels is perceptible; six or seven was regarded by the acoustic engineers who assisted us as significant,' she says. 'And this particularly benefits the children who struggle to concentrate the most.'

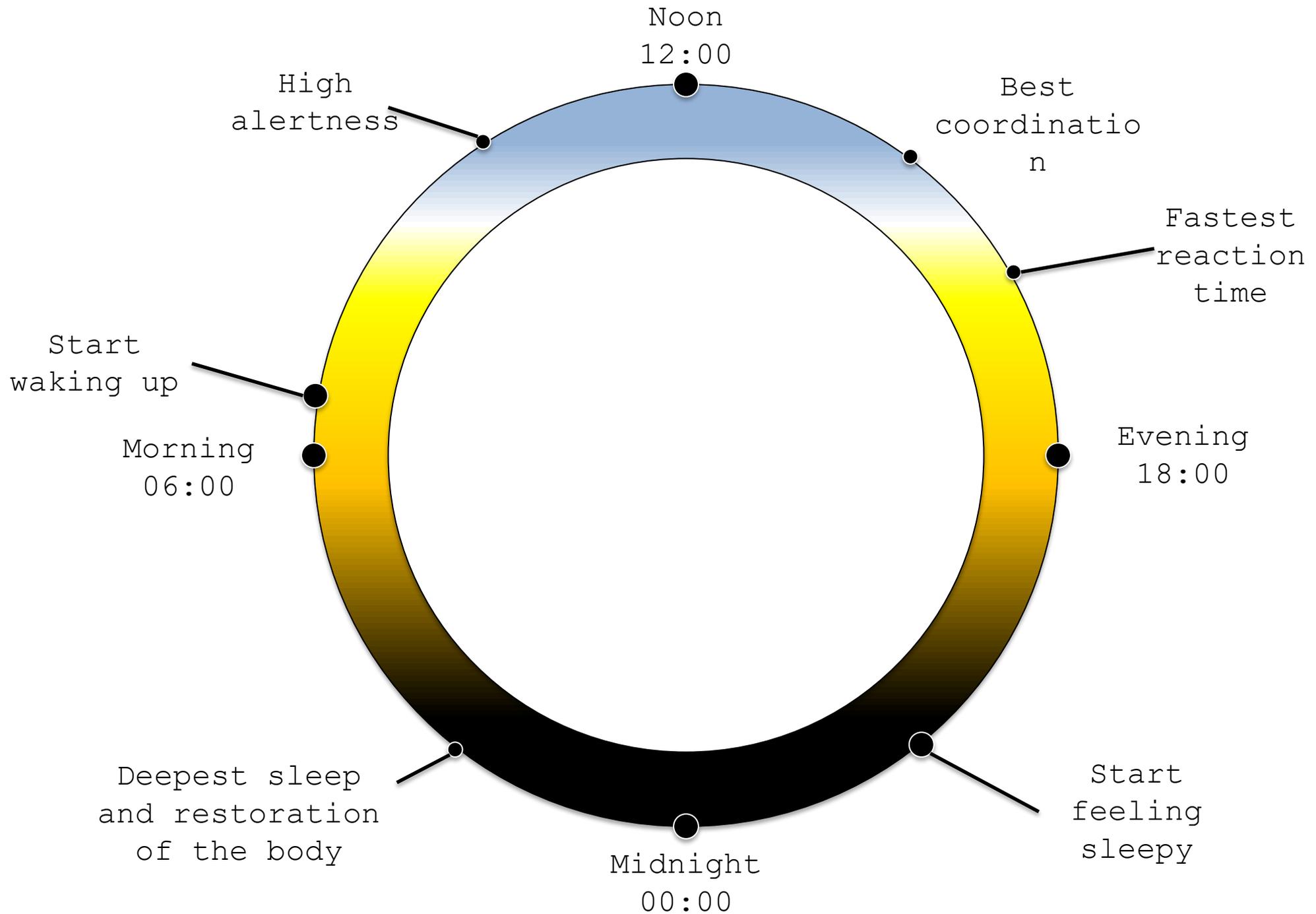
# HUMAN CENTRIC LIGHTING

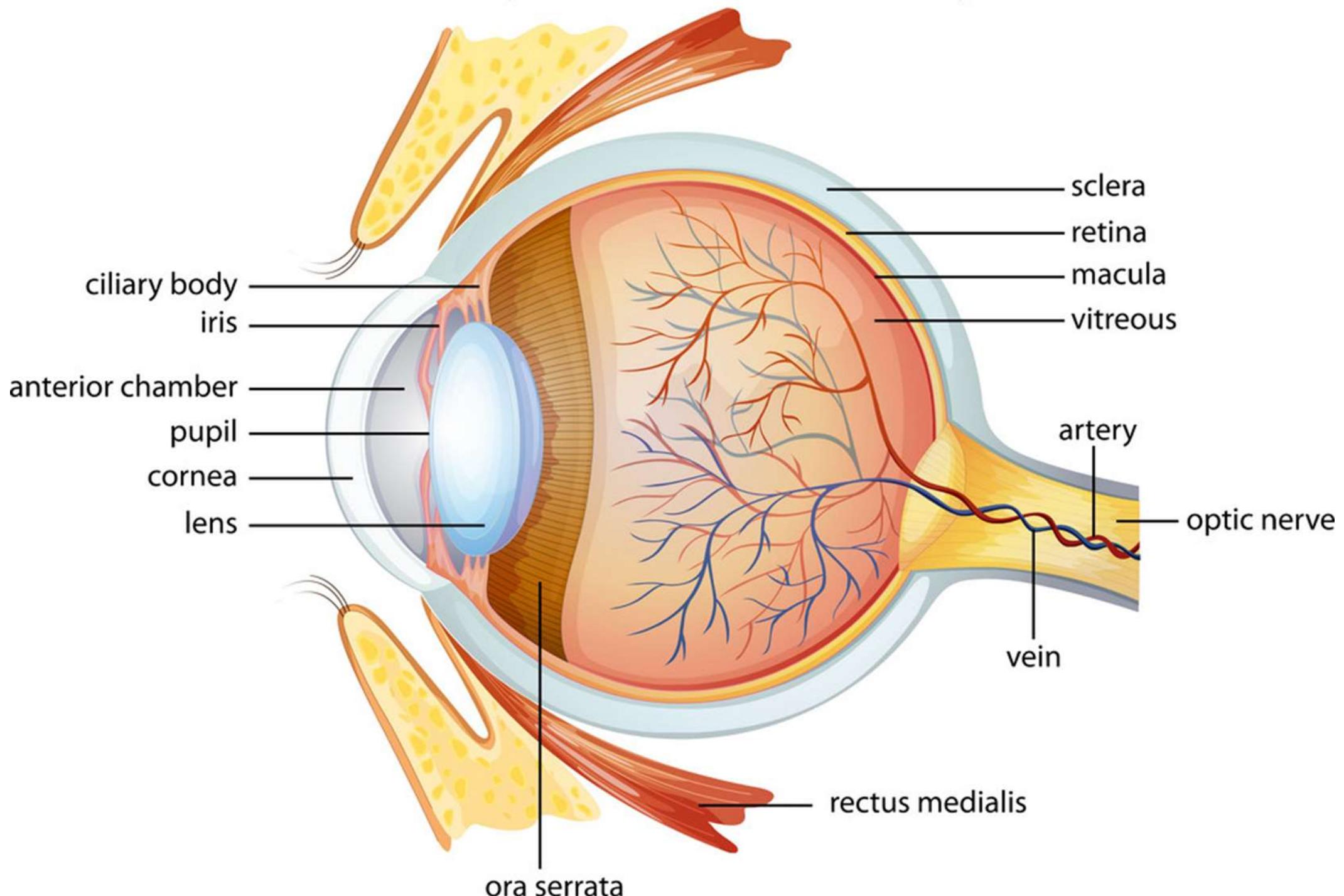


# ~~HUMAN CENTRIC LIGHTING~~

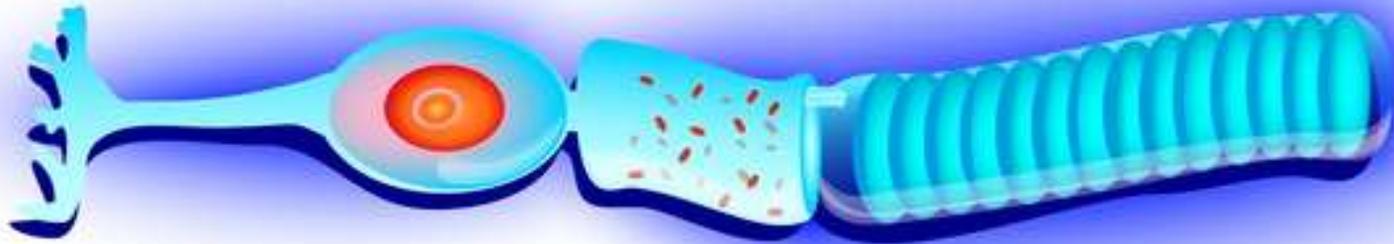


CIRCADIAN  
LIGHTING

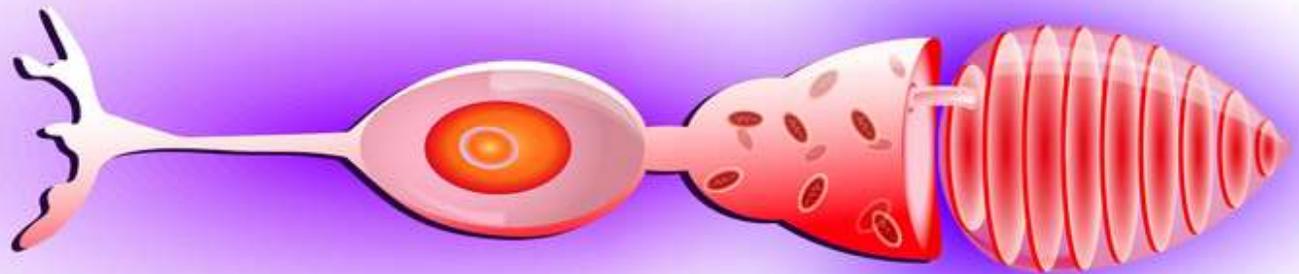


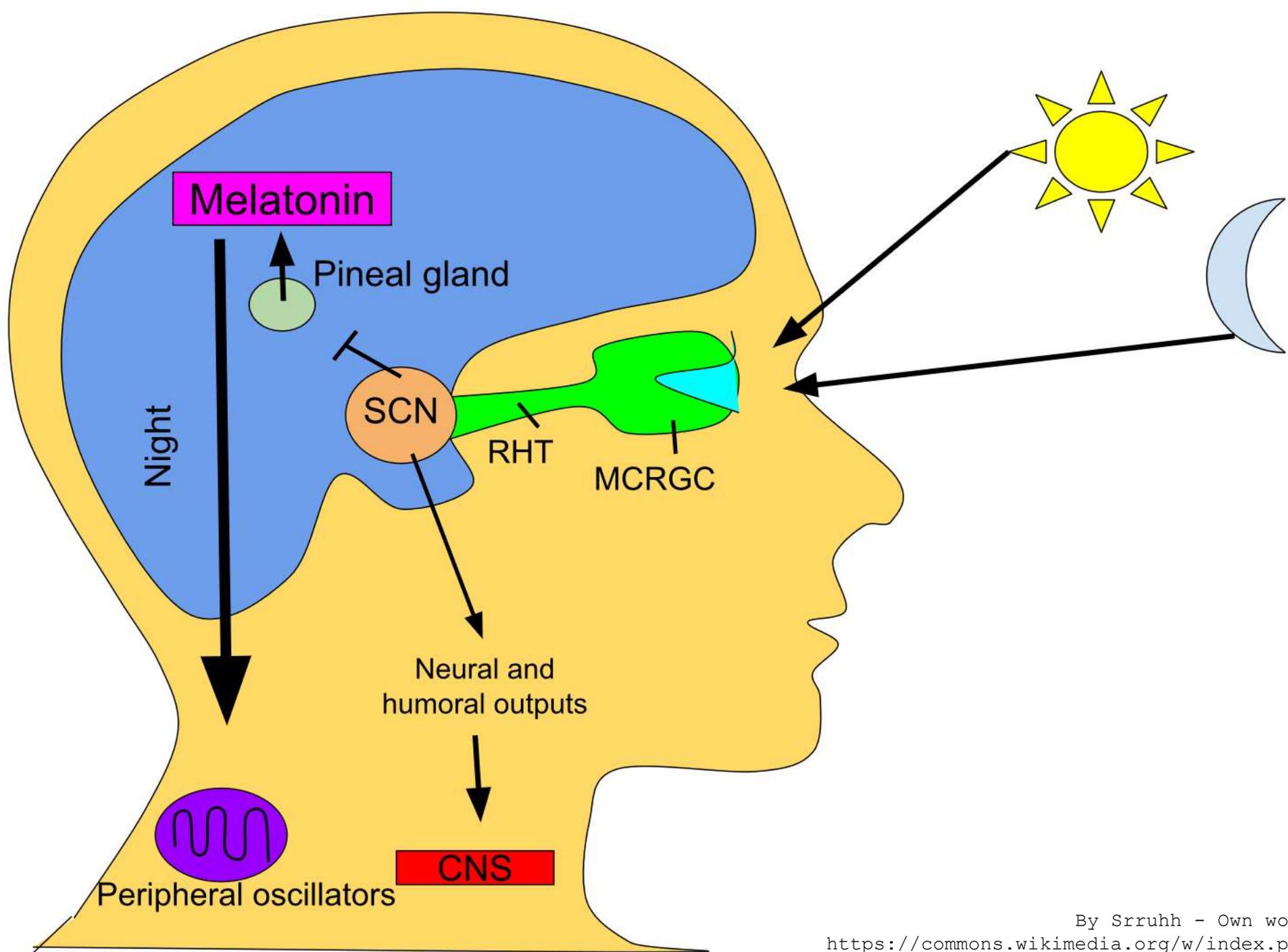


Rods



Cones





# THE WELL STANDARD



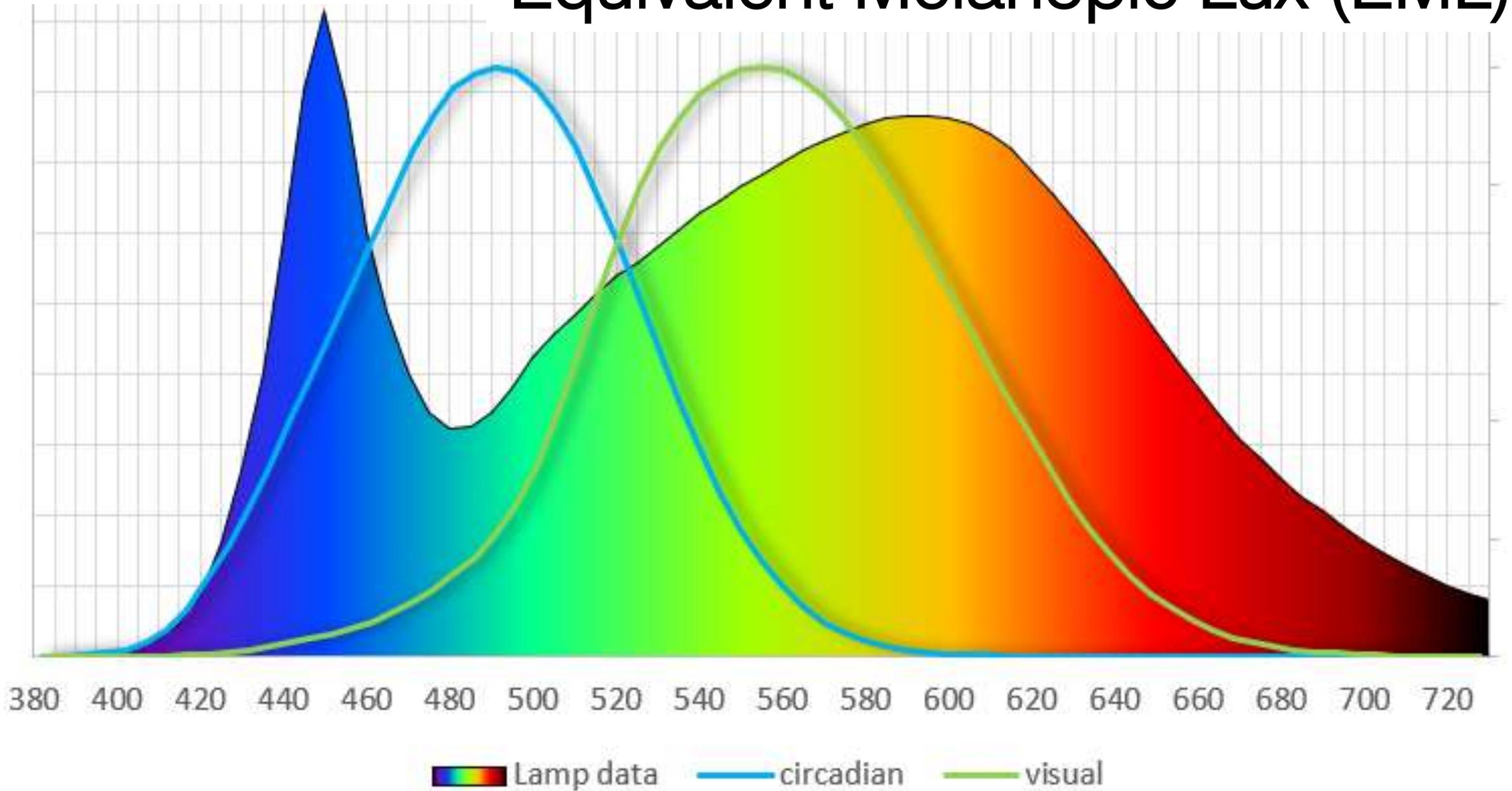

 Max  
 3 Pts

# Circadian Lighting Design

Support circadian health through interventions using electric lighting.

Electric Light Only		Electric Light and Daylight	Points
At least 150 EML [136 melanopic equivalent daylight D65]	OR	The project achieves at least 120 EML [109 melanopic equivalent daylight D65] with electric light and at least 2 points in Feature L05: Enhanced Daylight Access	1
At least 240 EML [218 melanopic equivalent daylight D65]	OR	The project achieves at least 180 EML [163 melanopic equivalent daylight D65] with electric light and at least 2 points in Feature L05: Enhanced Daylight Access	3

# Equivalent Melanopic Lux (EML)



$$\text{EML} = \text{L} \times \text{R}$$

Where EML = Equivalent Melanopic Lux

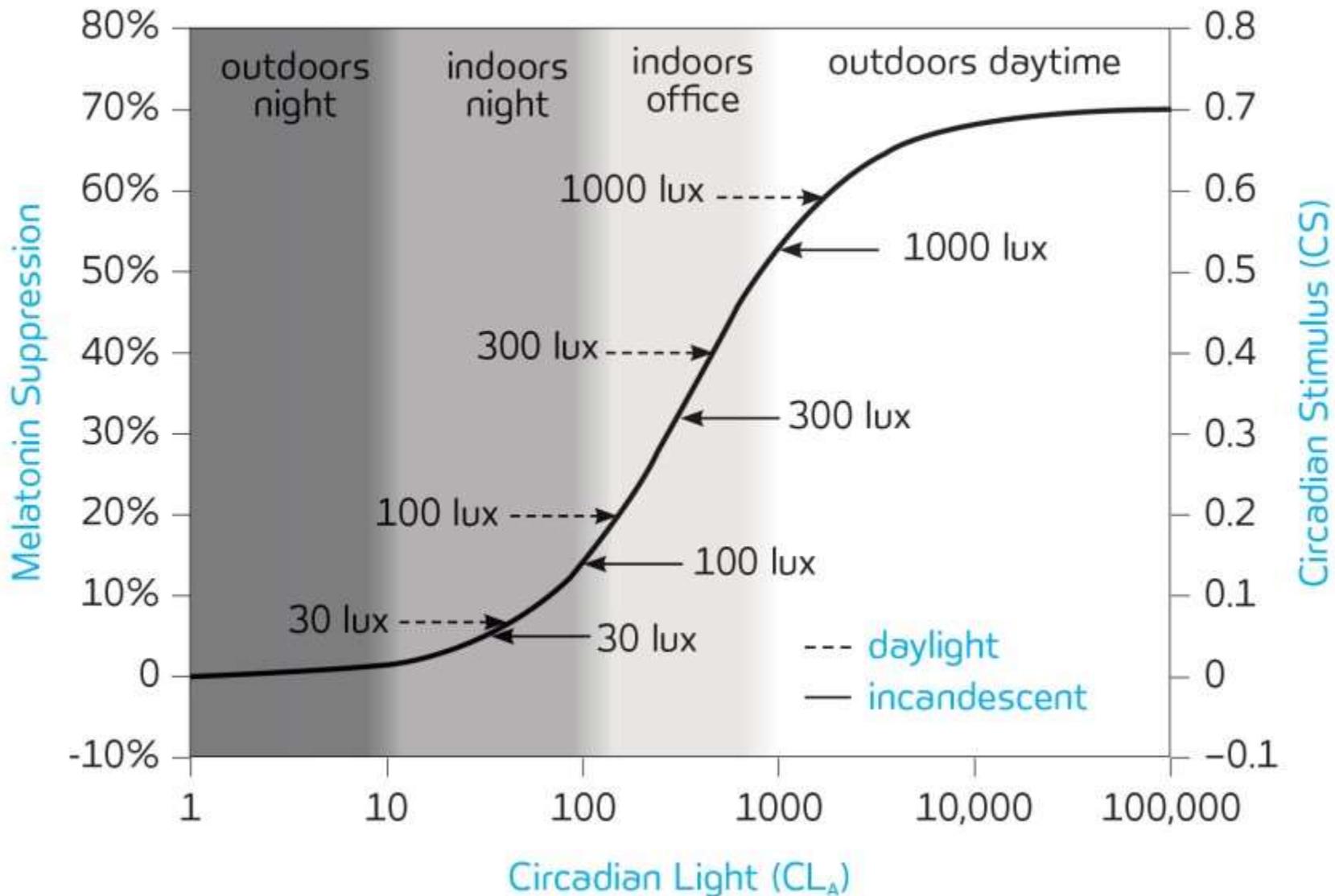
L = Lux Levels

R = Melanopic Ratio

Photometric units have not been established for the circadian luminous efficiency function; consequently, quantifying light in terms of melanopic lux has yet to be defined.

More importantly, the impact on the SCN by different levels of melanopic lux is completely unknown. It is thus impossible to use the action spectrum of melanopsin to describe the effectiveness of electric light or daylight for stimulating the human circadian system.

**FIGURE 2. CIRCADIAN STIMULUS VERSUS CIRCADIAN LIGHT**



**The Society of Light and Lighting**

**Position  
Statement**

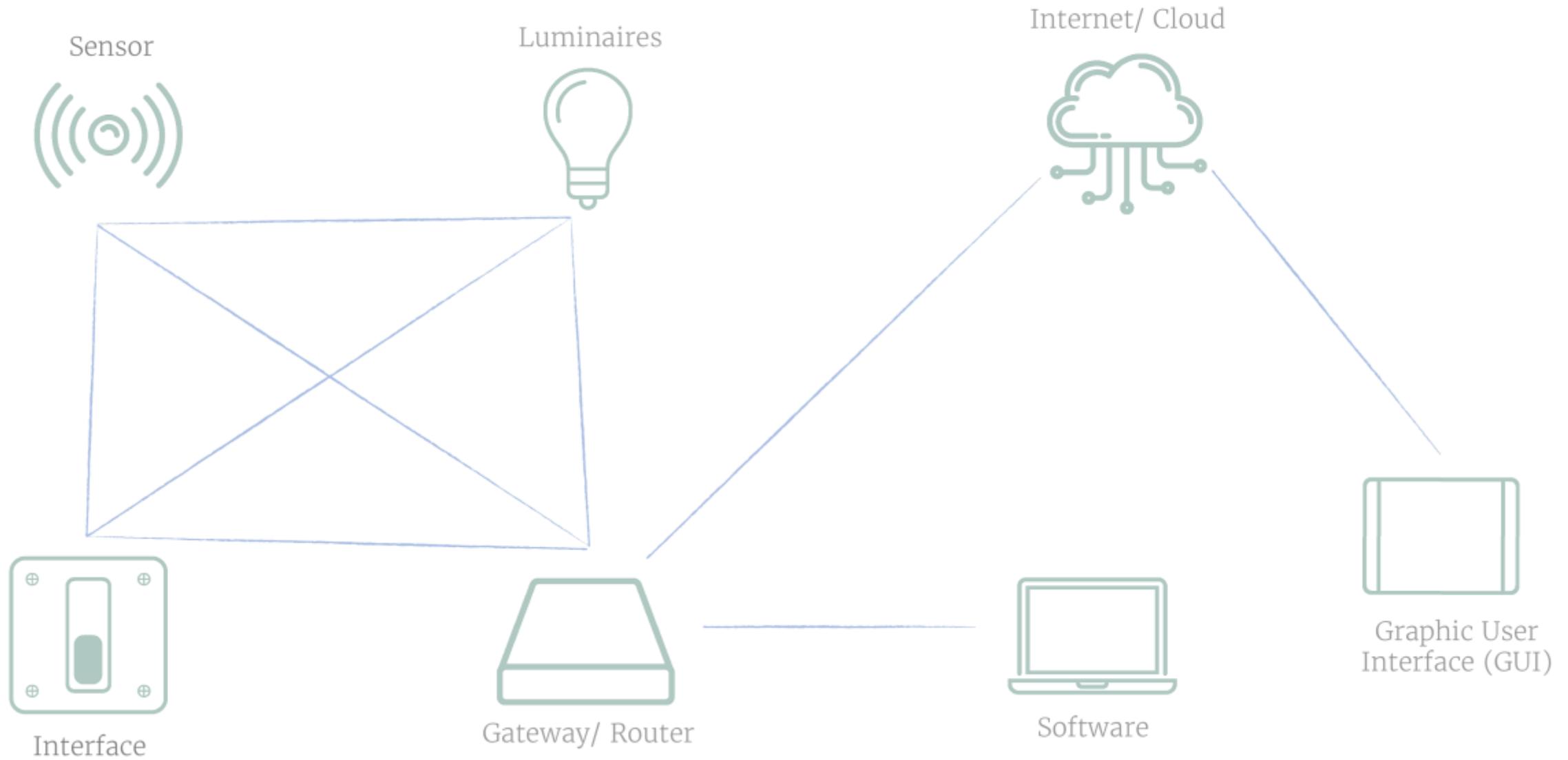


**Circadian Lighting**

**April 2019**

"we are a long way from  
knowing what light  
exposures have what  
effects"

# CONNECTED LIGHTING







Temperature



Occupancy



Light level



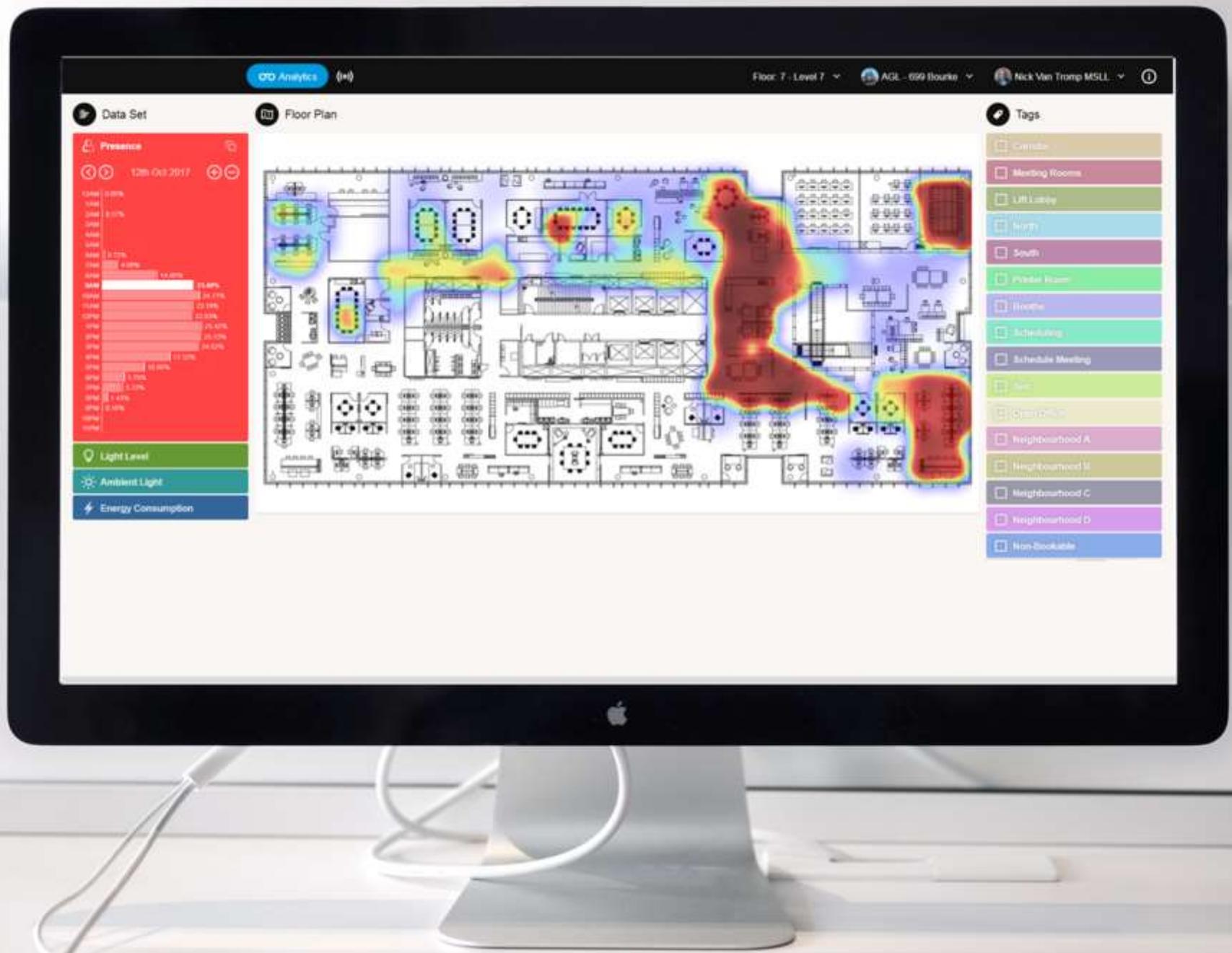
Energy consumption



Lamp run time



Emergency test



Analytics

Floor: 7 - Level 7

AGL - 699 Bourke

Nick Van Tromp MSLL

Data Set

Floor Plan

Tags

### Presence

12th Oct 2017

0001	0.0%
0002	0.0%
0003	0.0%
0004	0.0%
0005	0.0%
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0043	0.0%
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0046	0.0%
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0068	0.0%
0069	0.0%
0070	0.0%
0071	0.0%
0072	0.0%
0073	0.0%
0074	0.0%
0075	0.0%
0076	0.0%
0077	0.0%
0078	0.0%
0079	0.0%
0080	0.0%
0081	0.0%
0082	0.0%
0083	0.0%
0084	0.0%
0085	0.0%
0086	0.0%
0087	0.0%
0088	0.0%
0089	0.0%
0090	0.0%
0091	0.0%
0092	0.0%
0093	0.0%
0094	0.0%
0095	0.0%
0096	0.0%
0097	0.0%
0098	0.0%
0099	0.0%
0100	0.0%

Light Level

Ambient Light

Energy Consumption



- Concierge
- Meeting Rooms
- Lift Lobby
- North
- South
- Printer Room
- Reception
- Scheduling
- Schedule Meeting
- Sea
- Open Office
- Neighbourhood A
- Neighbourhood B
- Neighbourhood C
- Neighbourhood D
- Non-Bookable

Rr 138 8/9

KILOWATTHOURS



x 100

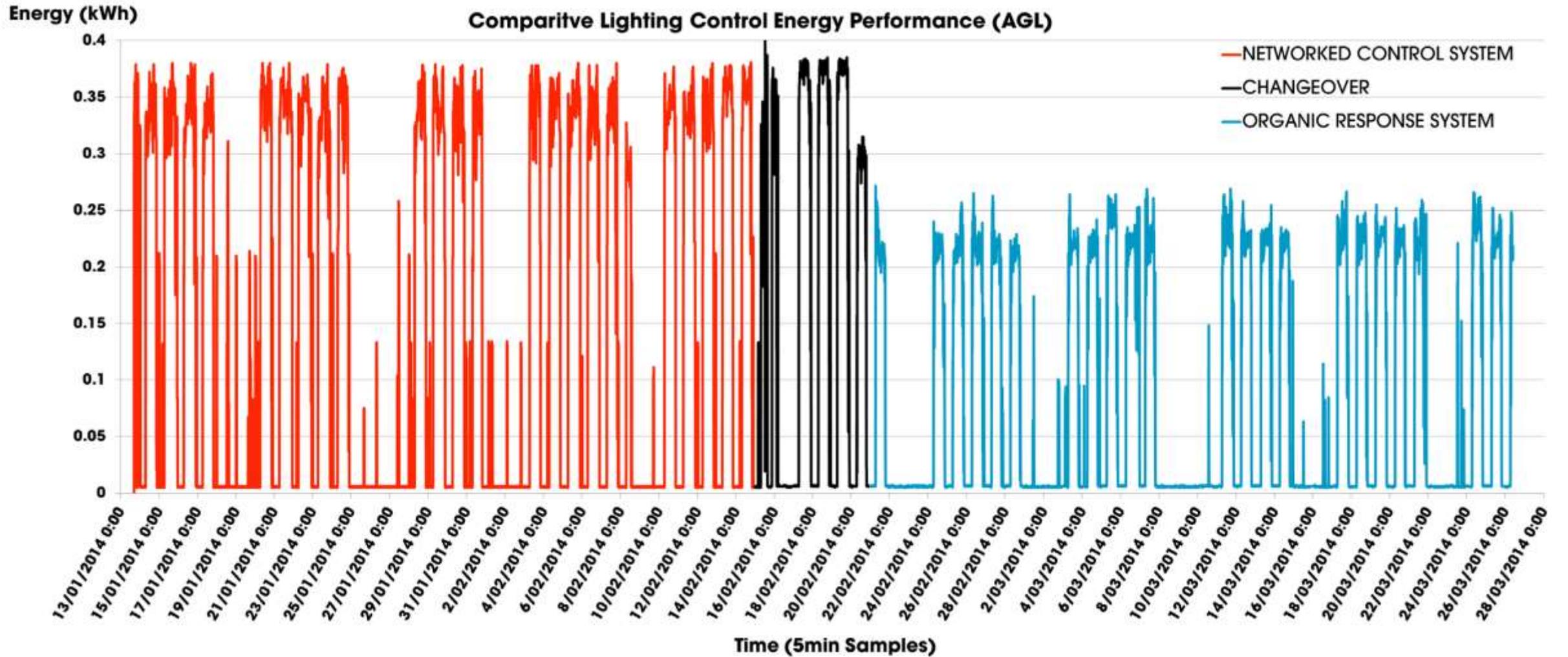
LANDIS & GYR

PSE

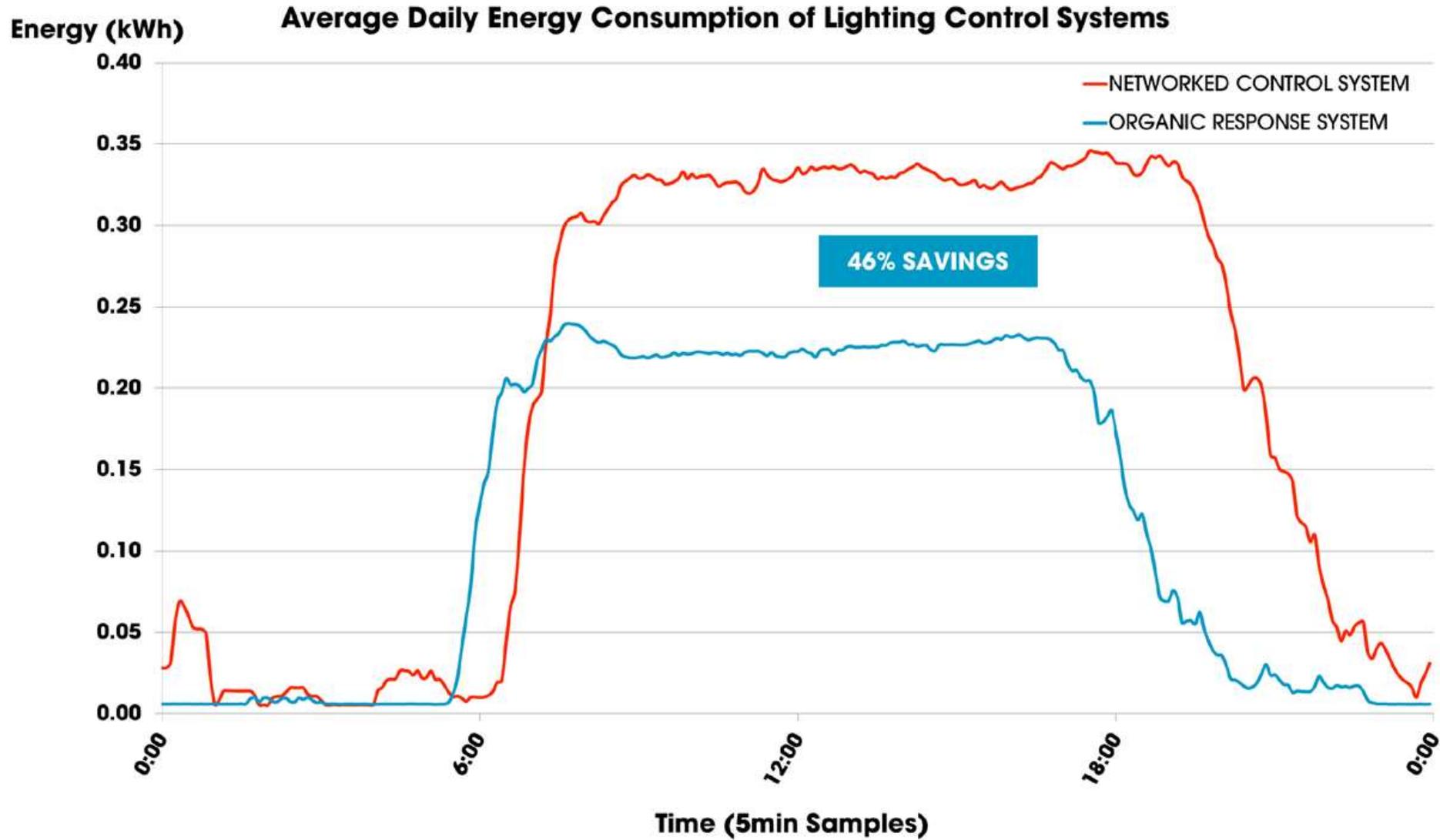


837173254

Partner	Mirvac & AGL
Locatio	Melbourne, AUS
Results	46% Control



Partner	Mirvac & AGL
Locatio	Melbourne, AUS
Results	46% Control



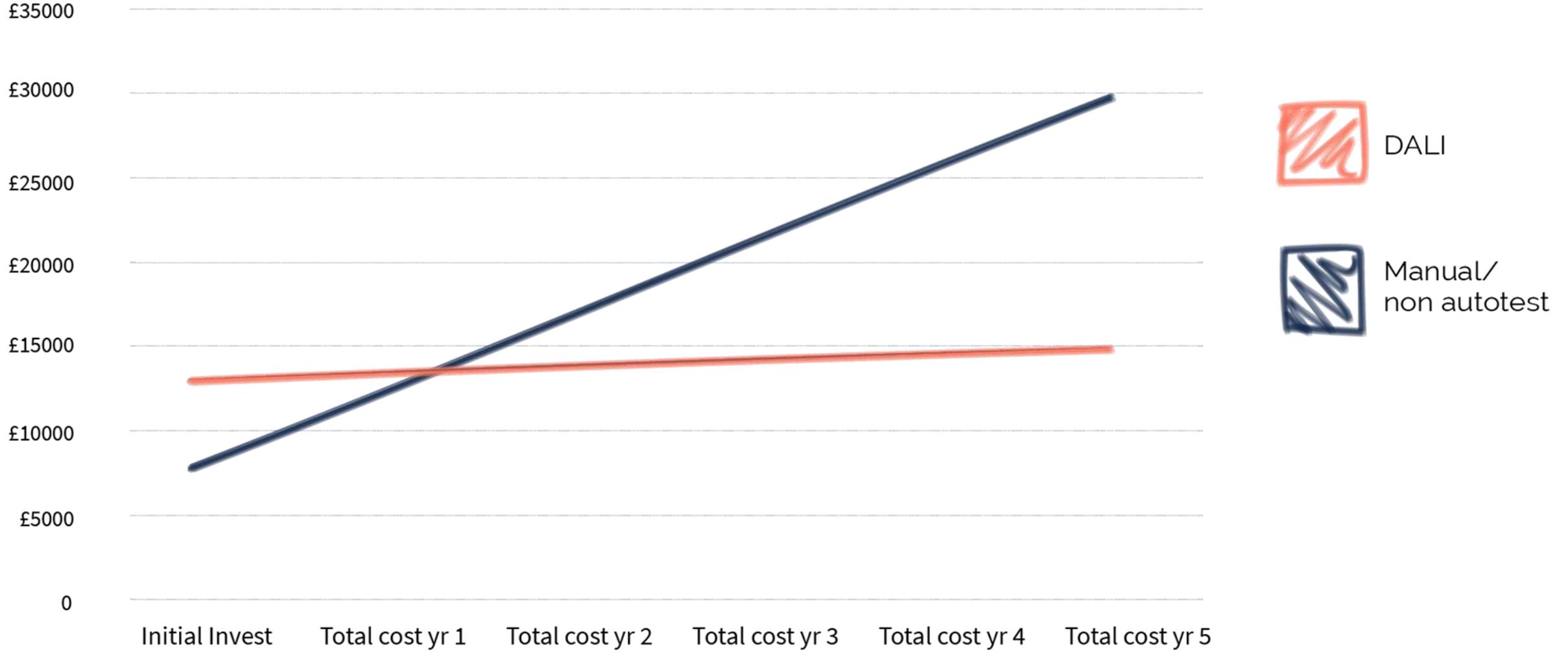


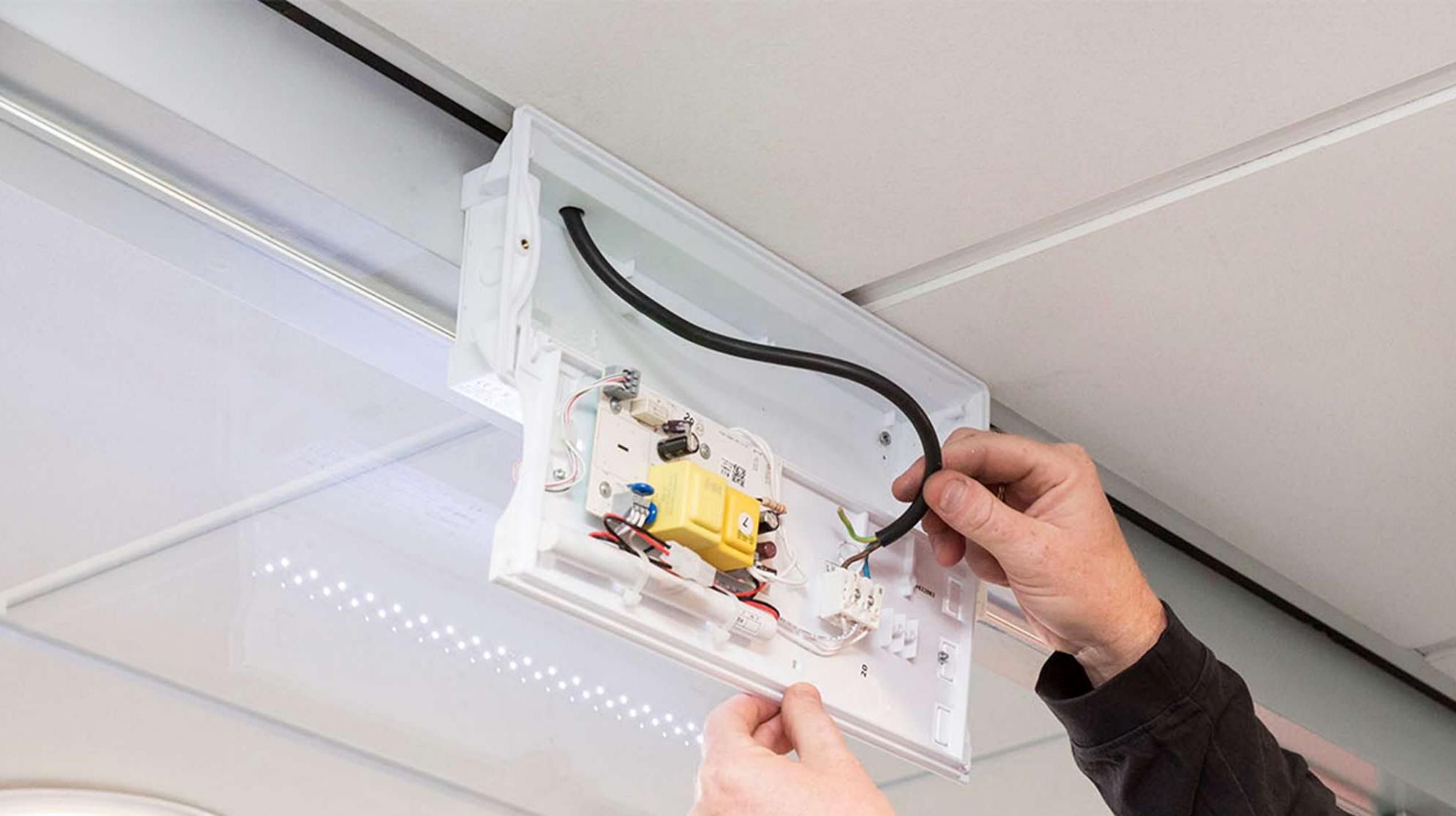
TEST

<b>Testing Costs</b>	<b>Manual Test</b>	<b>Central Test</b>
Number of Luminaires	106	106
Function Testing Time (Mins)	561.8	20
Hours Per Year	112.36	4
Duration Testing Time (Mins)	741.8	400
Hours Per Year	12.36	6.67
Labour Cost per Hour	£ 35.00	£ 35.00
<b>Total Onsite Cost</b>	<b>£ 4,365.32</b>	<b>£ 373.33</b>

<b>Investment Costs</b>	<b>Manual Test</b>	<b>Central Test</b>
Number of Luminaires	106	106
Cost per Luminaire	£ 70.00	£ 100.00
Luminaire Costs	£ 7,420.00	£ 10,600.00
Wiring + Install Costs	£ 500.00	£ 1,000.00
Commissioning Costs	£ 0.00	£ 1,500.00
<b>Total Onsite Cost</b>	<b>£ 7,920.00</b>	<b>£ 13,100.00</b>

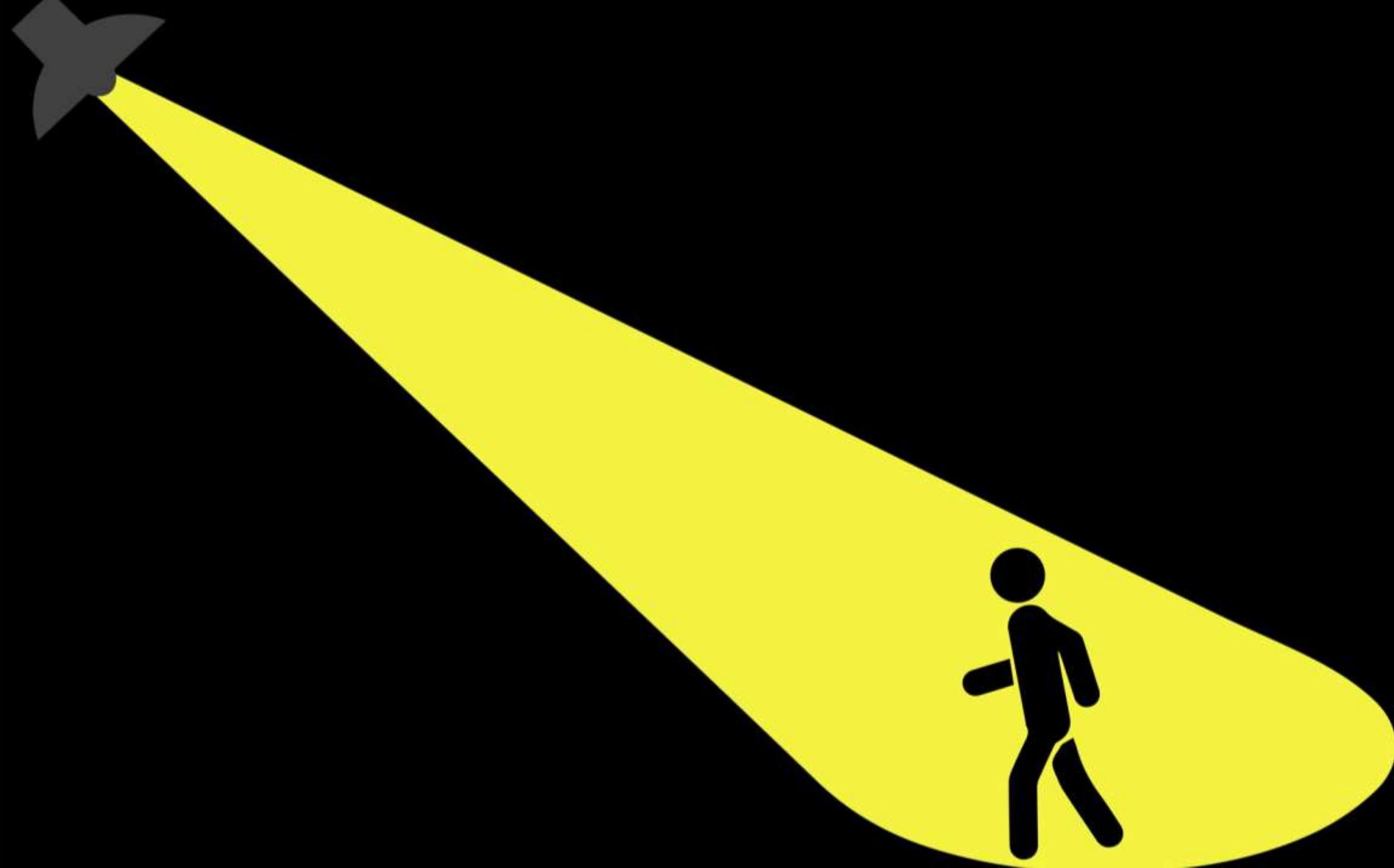
# Payback Time DALI vs Non-Monitored Single Site 106 luminaires











## Summary

Lighting within education plays an important role in enhancing learning

Emergency Lighting is a necessity

Circadian Lighting is still at an early stage more research is required

Lighting controls excellent for energy and cost savings.

# FAGERHULT

Thank  
You!