P5 Graduation - 04/07/2014

POLYCARBONATE MEDIA FACADES

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1st mentor: Prof.dr.ing. Ulrich Knaack

2nd mentor: Ir. Joris Smits

External examiner: Ir. Cecile Calis

TU Delft

The problem statement

My fascination when applying to TU Delft (media facades)

- Facade companies' opening in NL investing in media facades

- Marketing importance and advertisement

- Media facade for an office building by Rollecate

- Upgrade polycarbonate facades

Building examples(case studies)

Rodeca

Rollecate office

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Criteria

What is the state of the art technology to design a multimedia facade and which are the ways to improve it?

- **Transparent** material (not a totally blocked view)
- Good quality **graphics** (videos and images)
- Competitive **price** (comparison)
- **Maintenance** and reversibility (fixing possibilities)
- **Day** and **night** use (intensity of lights)

Simple & cheap solution

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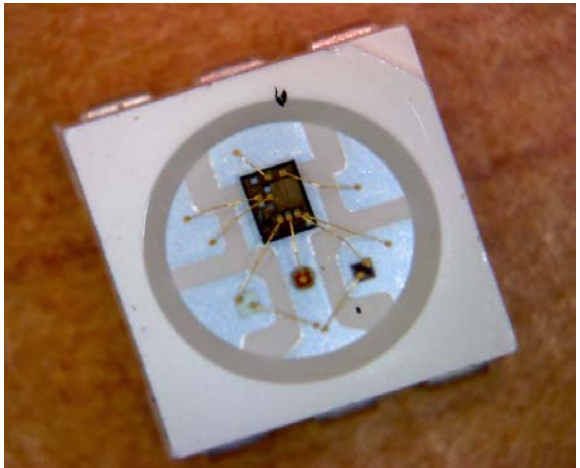
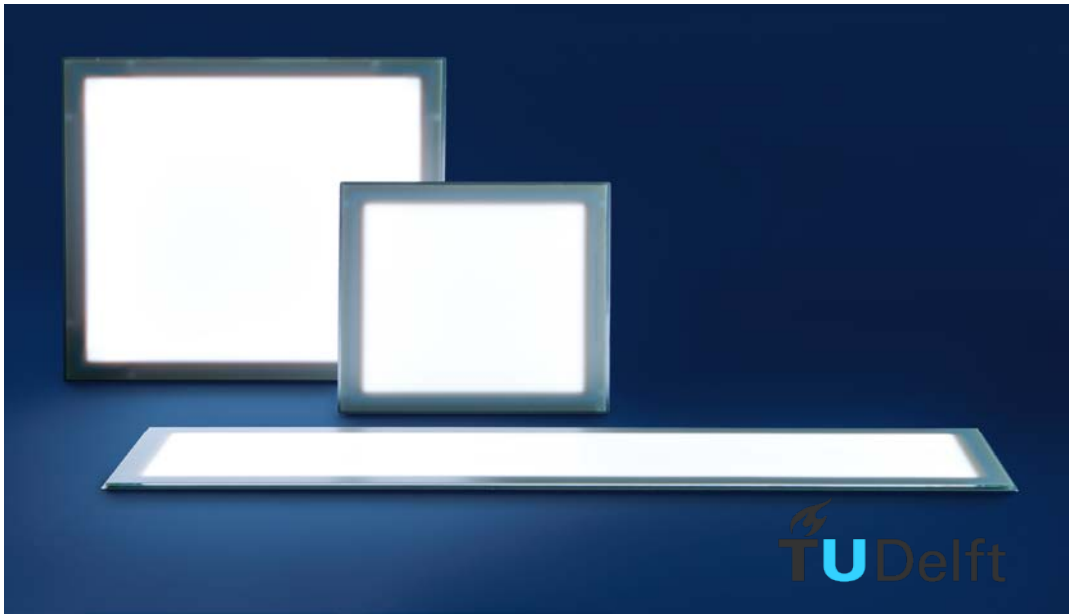
First part of the research

- Related to media facade **technologies** and **costs**

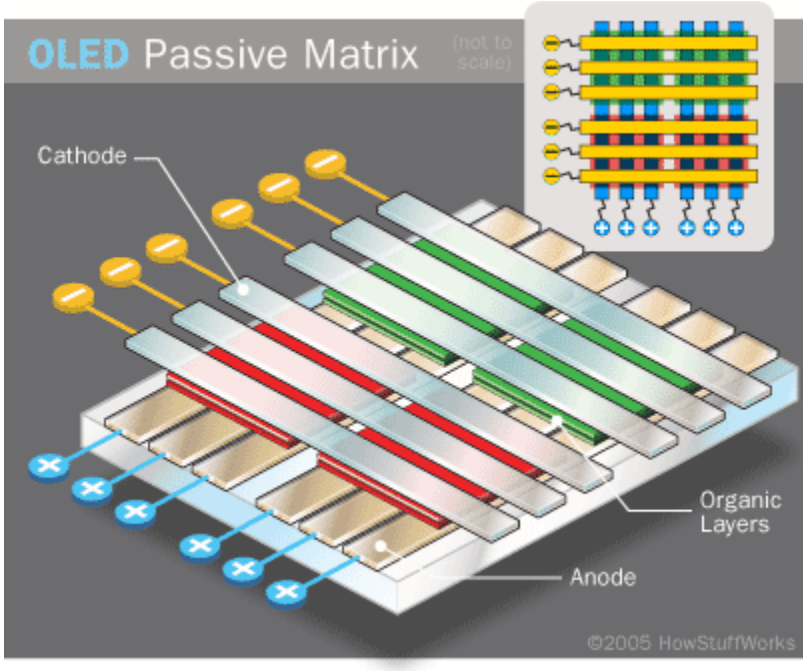
- What technology do they use?(LEDs and OLEDs)

- LEDs and OLEDs (lifetime, efficiency, cost, brightness)



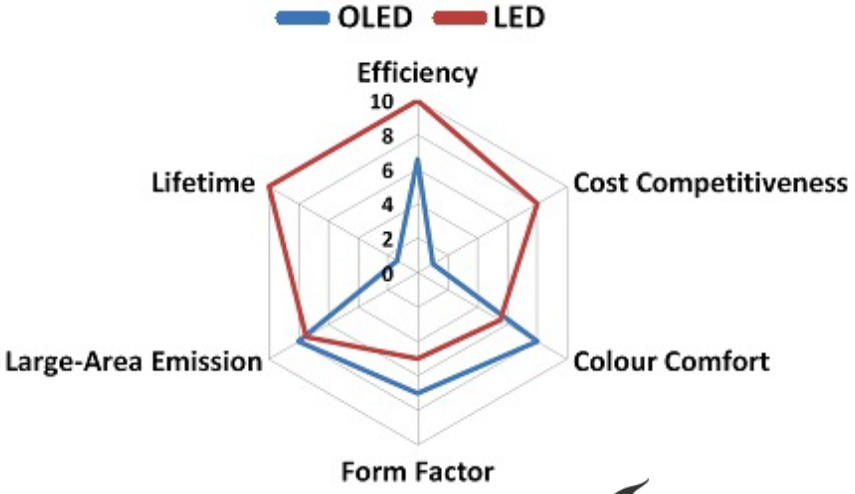


LEDs and OLEDs



• Limited lifetime of the **organic materials** (carbon)/thinner layer/sensitive to oxygen/UV exposure (degradation). Life span of LEDs 50.000h - OLEDs 15.000h

• Efficiency (how well a light source produces visible light) of OLEDs is 100lm/W under test while on LEDs 200lm/W in production



• Manufacturing processes are too expensive and under testing constantly

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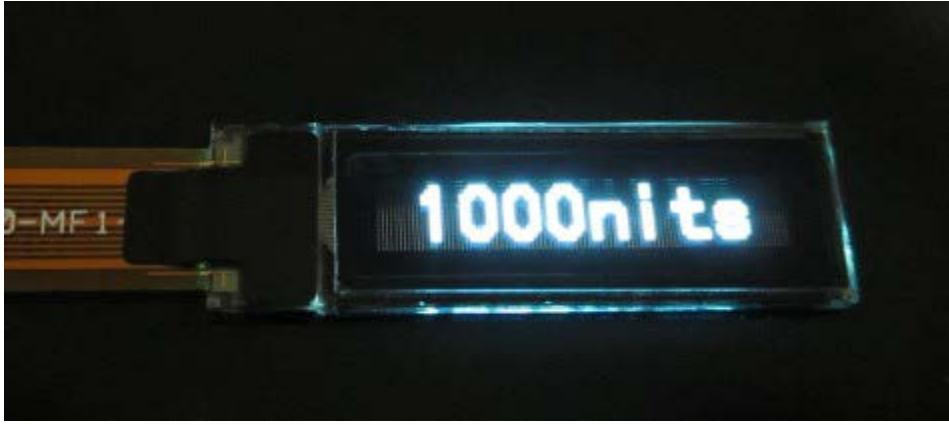
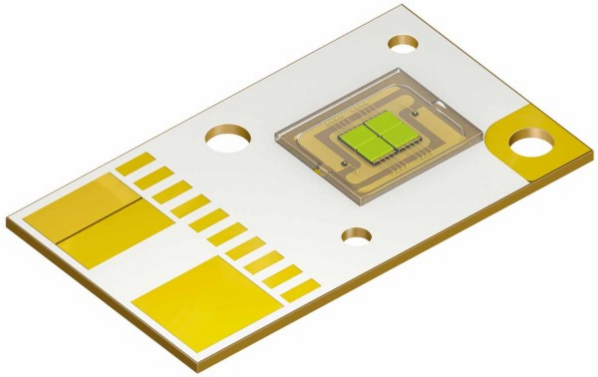
LEDs and OLEDs

• Brightness of LEDs already 1.700 nits and will reach 8.000 while OLEDs recently developed the first PMOLED with 1.000 nits





• OLEDs are more appropriate for small applications to achieve high contrast and resolution

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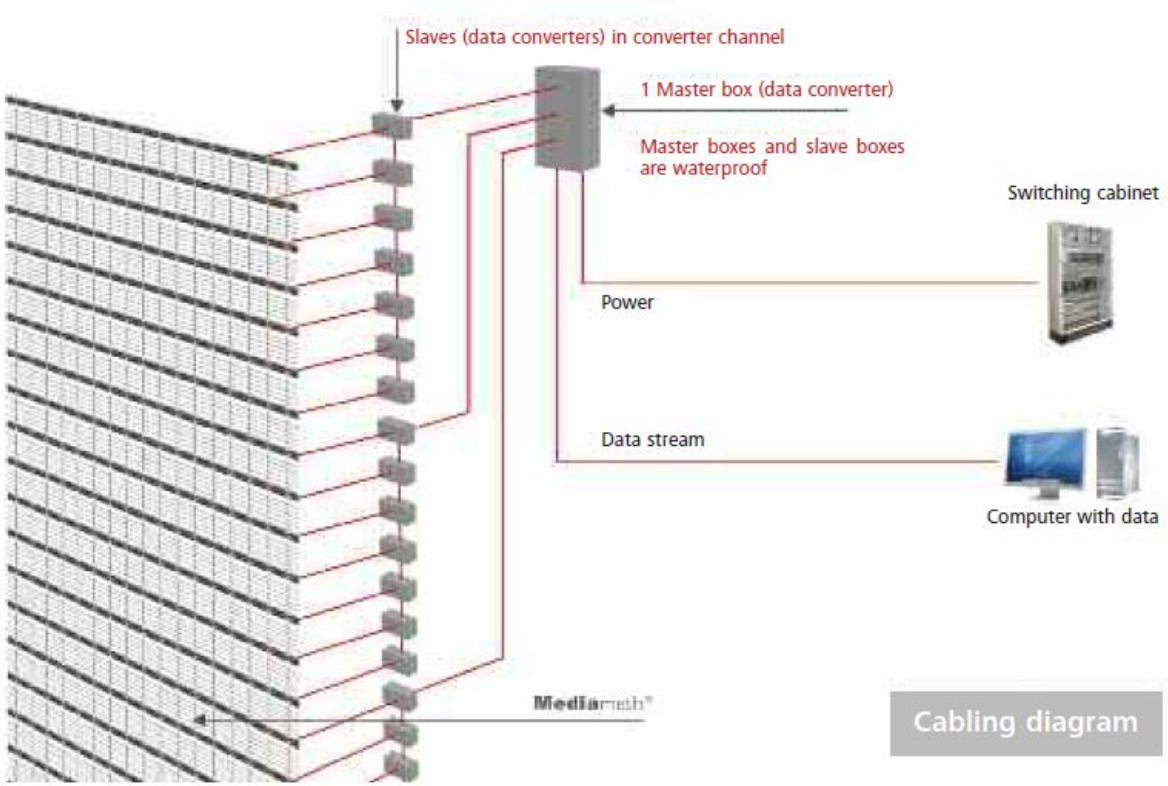
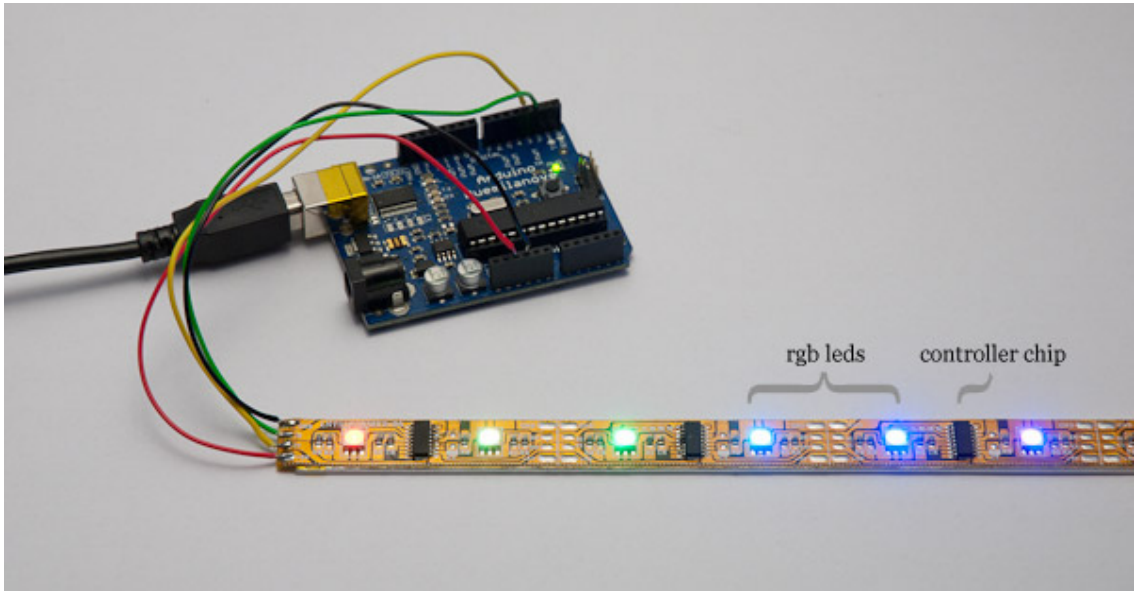
Addressable RGB strip

What is the technology to produce animated images with LEDs?

- GND = **Ground**(close the circuit)
- Di= **Data in** (data input for the controller chips)
- 5V= **Volts** (power supply)





Chips between LEDs take commands from a **microcontroller**

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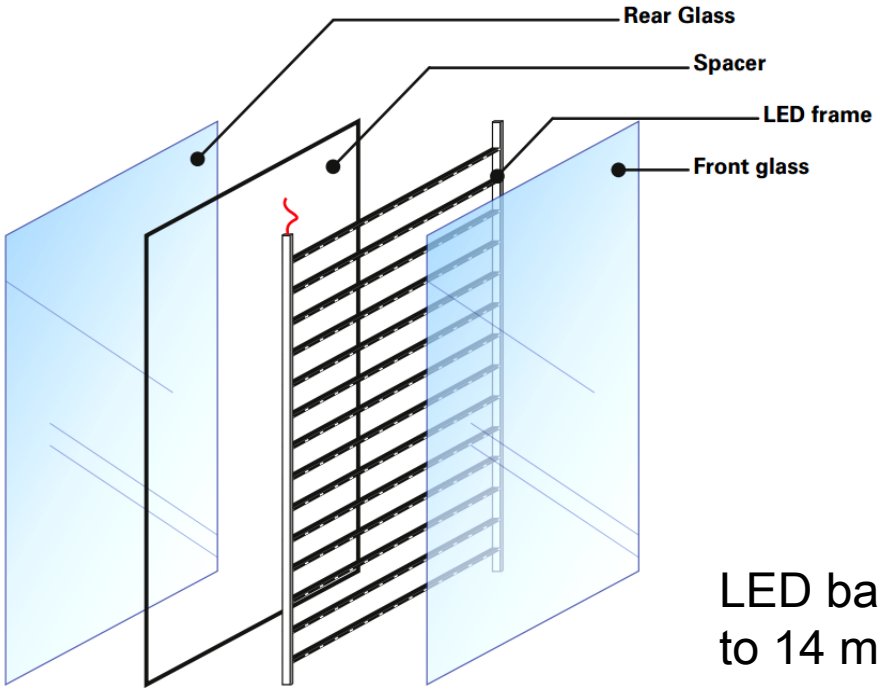
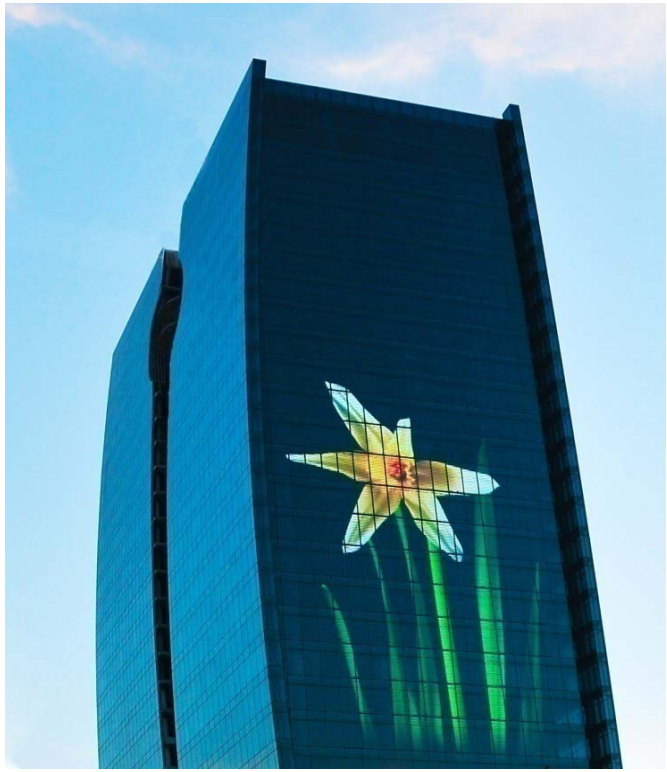
Media facade technologies

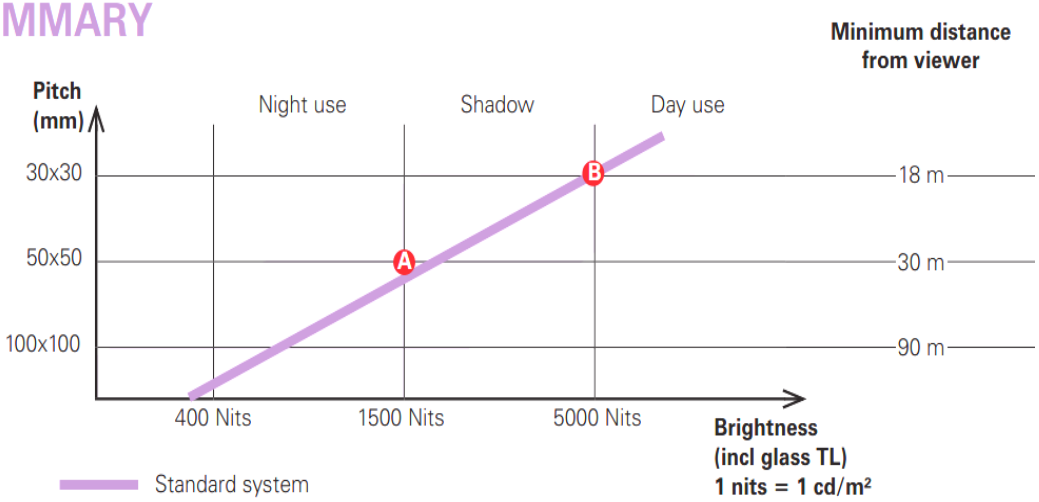


LED bars are 8 to 14 mm thick

King's Road Tower, Jedahh



SUMMARY



• Black grid
• Maintenance
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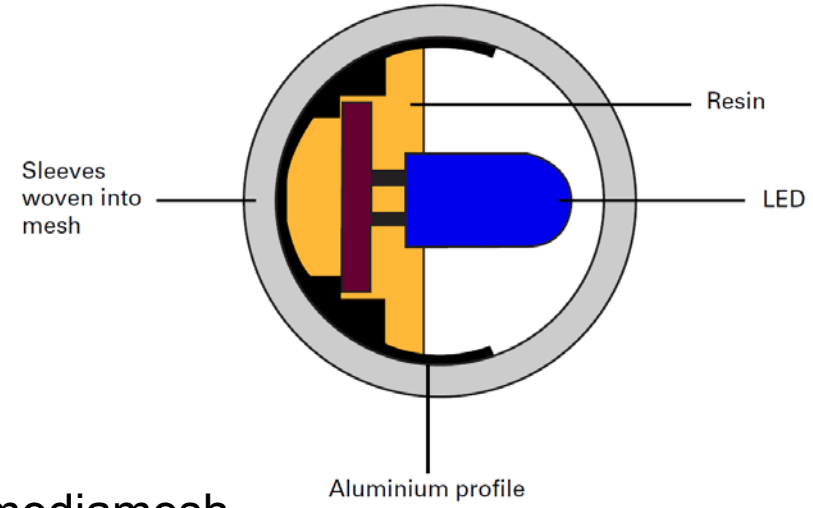
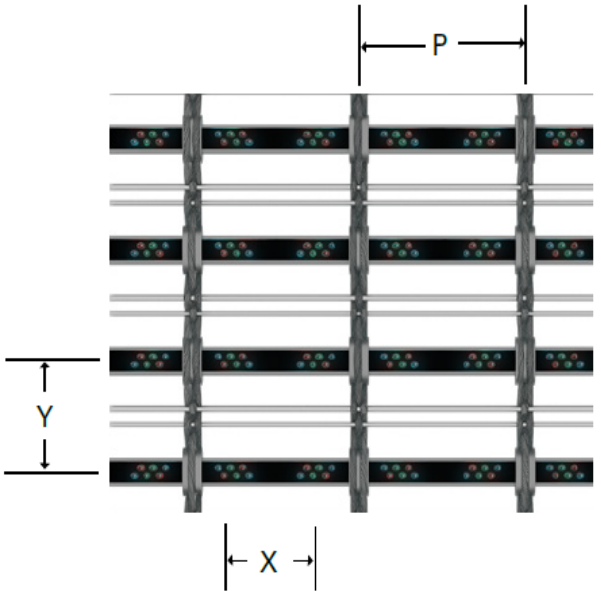
Media facade technologies



mediamesh

Specification	V4xH5.0	V5xH5.0	V6xH5.0
Vertical LED Pitch	40mm	50mm	60mm
Horizontal LED Pitch	50mm	50mm	50mm
NIT m²	7766-9527	6213-7621	5177-6351
Open Area	56.2%	58.1%	59.4%
Viewing Distance	35m/115ft	35m/115ft	42m/138ft
Weight (lbs per ft²)	1.9	1.77	1.7
Rods Between LED Tubes	1	2	3

*table data February 2013

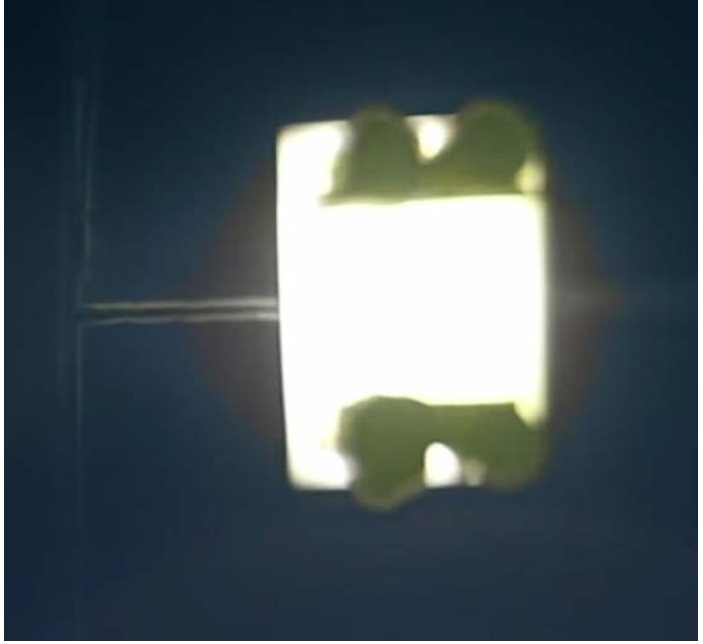


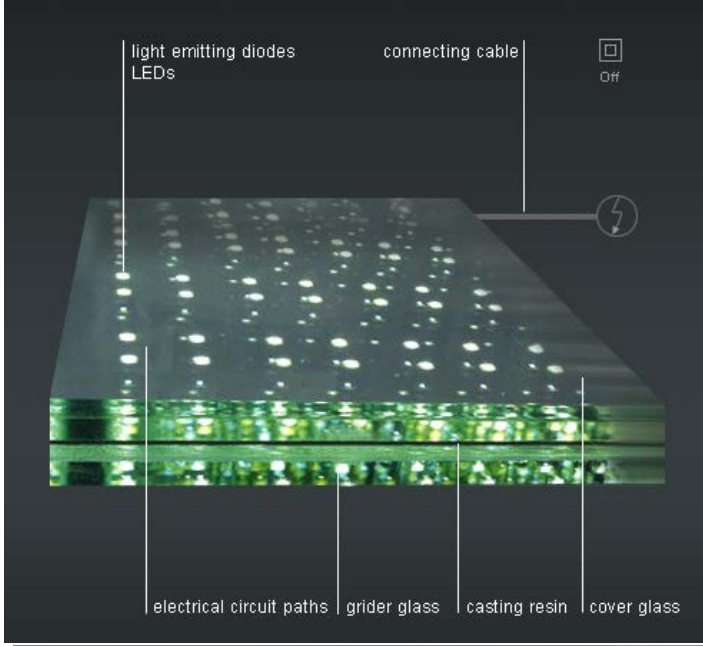
P= cable pitch
X= horizontal pixel spacing
Y= vertical pixel spacing

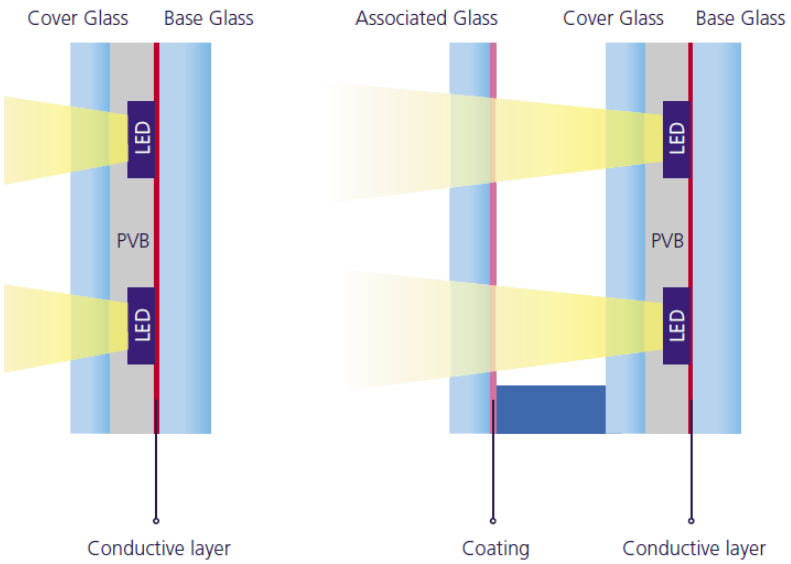
- Maintenance
- Additional element

Powerglass

•Transparent wires but limitation in pixel pitch, graphics and serviceability



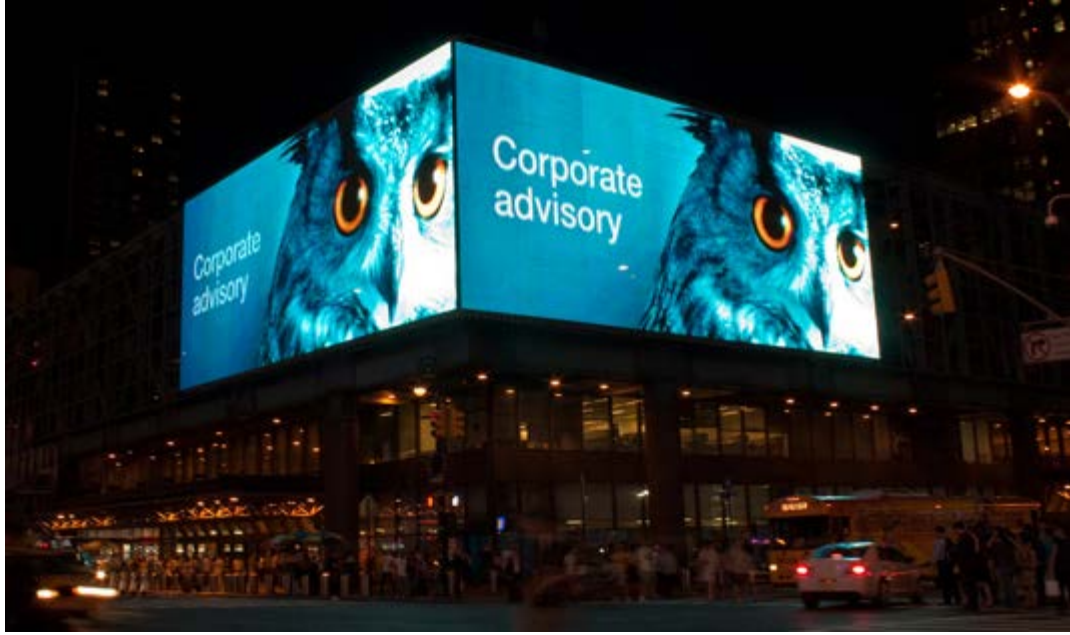




Cost of media facades

Filters:
- good quality **graphics**,
- **day-night** use,
- **top** companies
- **light transmission** allowance

Depends mainly on **pixel pitch** and **brightness**



GKD 7.000€/m²
Bus Authority 557m² - 4 million €
Pixel pitch 50 mm
Brightness 4.730 nits

LEUROCOM 7.000€/m²
Imaginarium 23m² - 160.000 €
Pixel pitch 25 mm
Brithgness 5.000 nits

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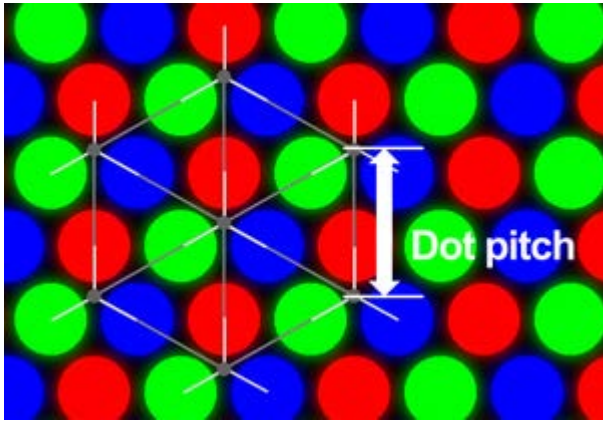
Rollecate media facade cost

Brakel Atmos
32 m² 203.000 €
6.000 €/m²
Pixel pitch 45 mm
Britghness 5.000 nits

Day and night use



Philips
63 m² 213.000 €
3.400 €/m²
Pixel pitch 50 mm
Britghness 1.040 nits

Night use

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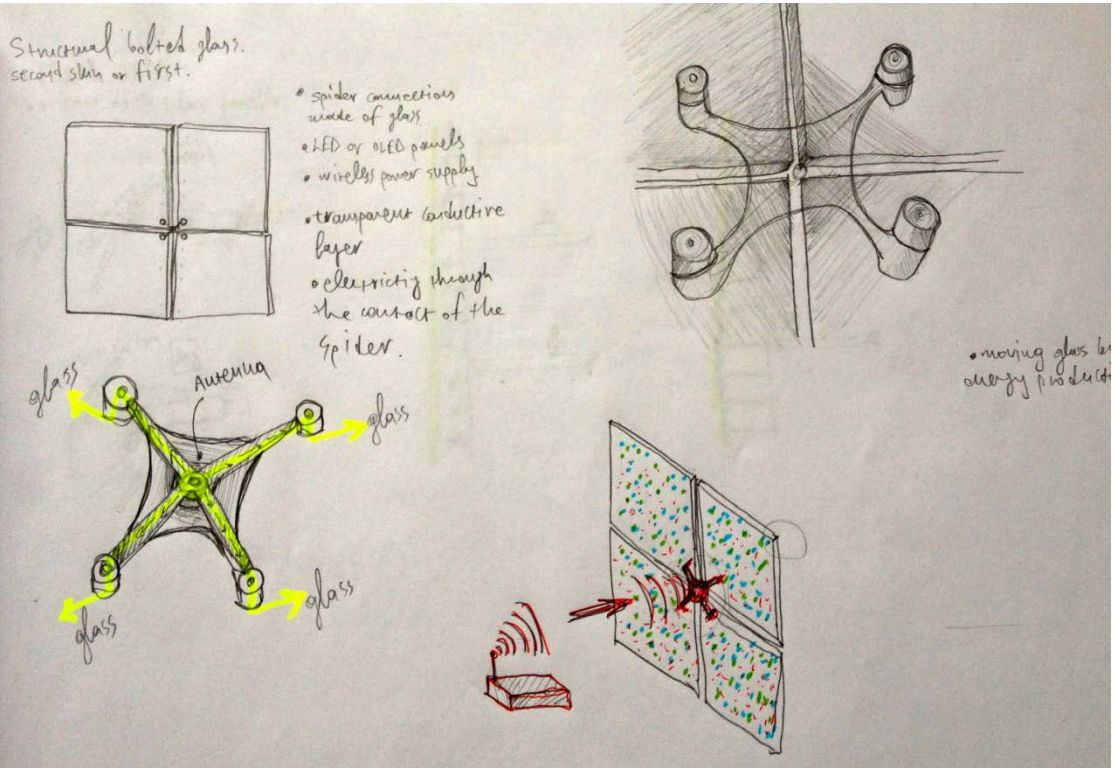
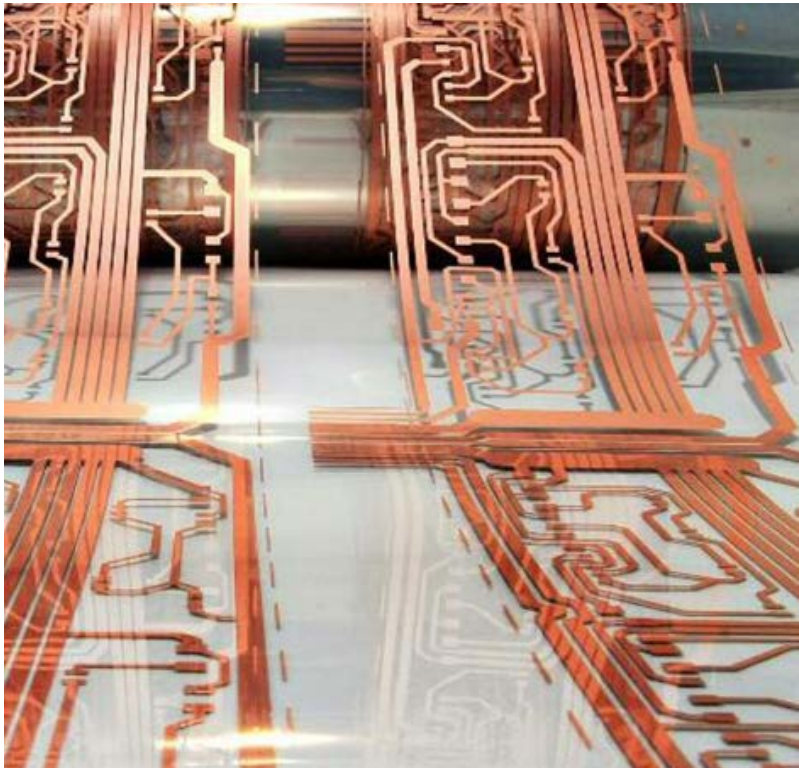
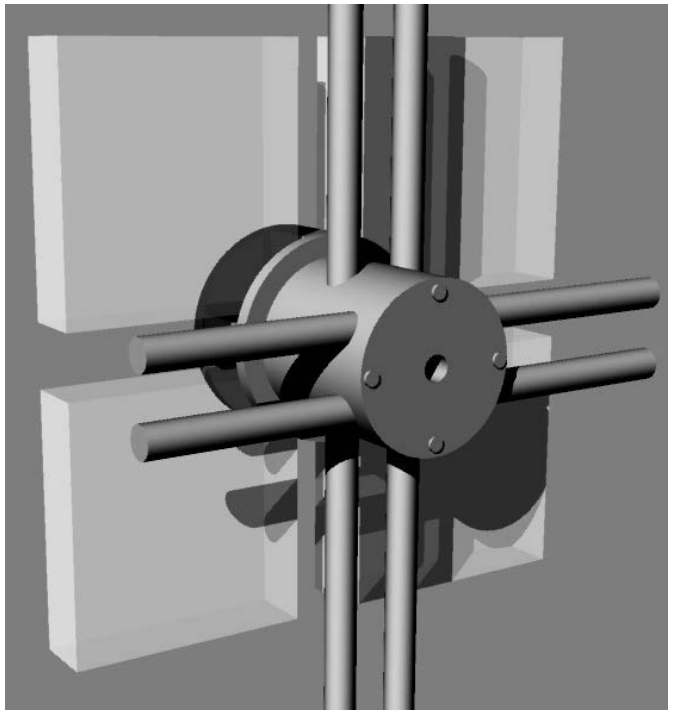
1st design attempt

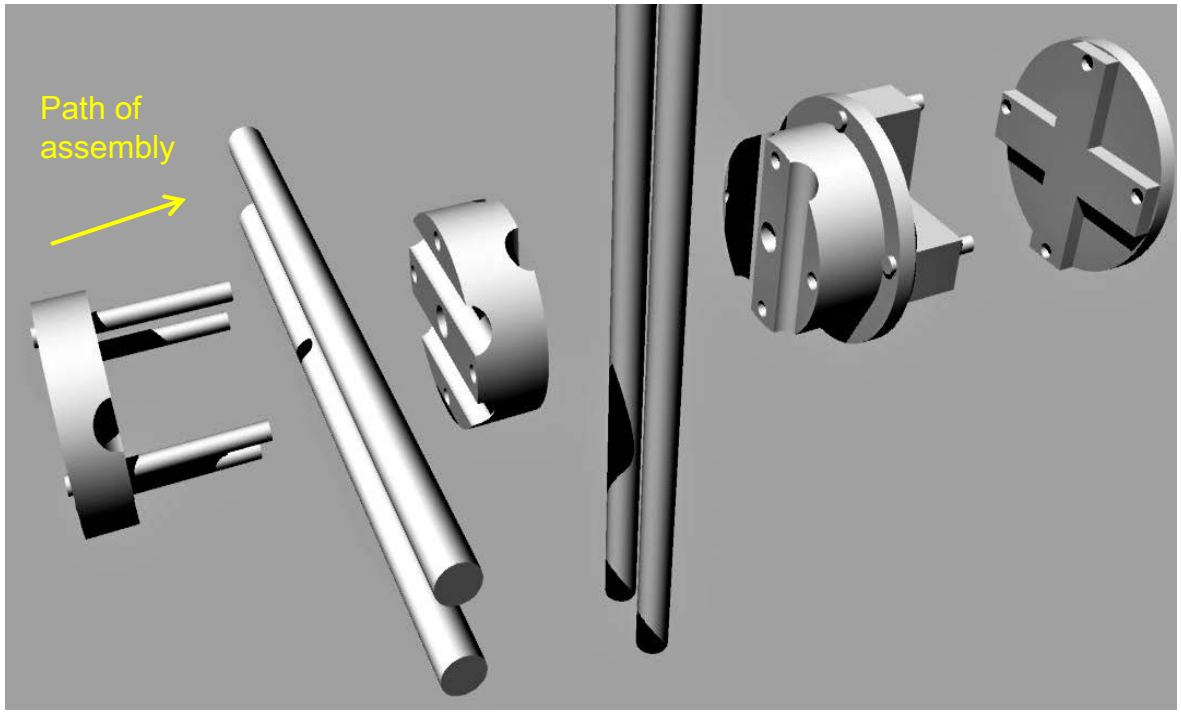
- Glass integrated LEDs with no mullions
- Minimise the connections between the panels and **spider glazing** solution
- Use of transparent PCB circuits for more light transmission

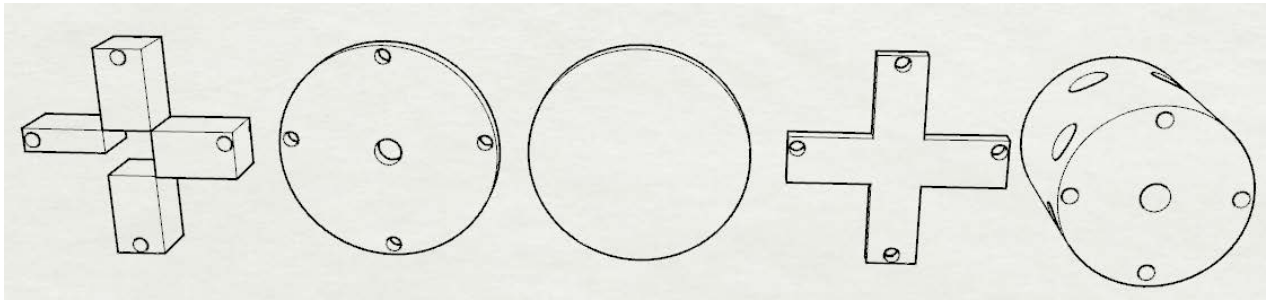


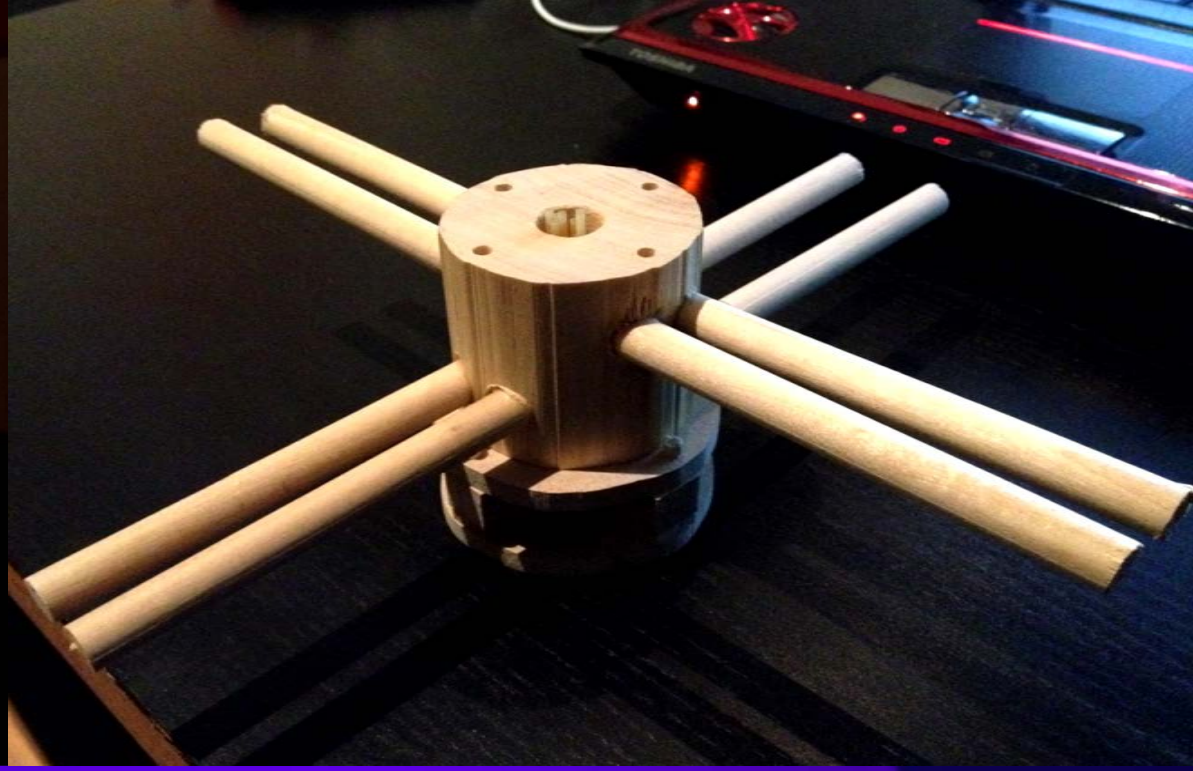


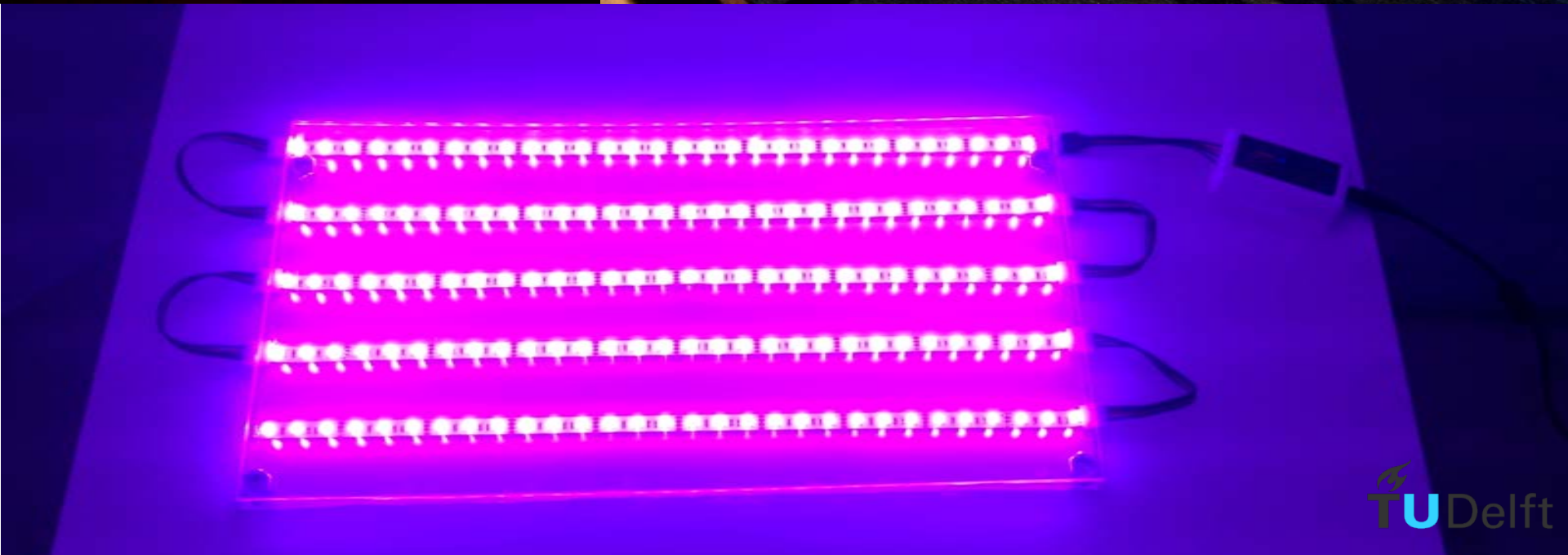
2D planar component







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Issues

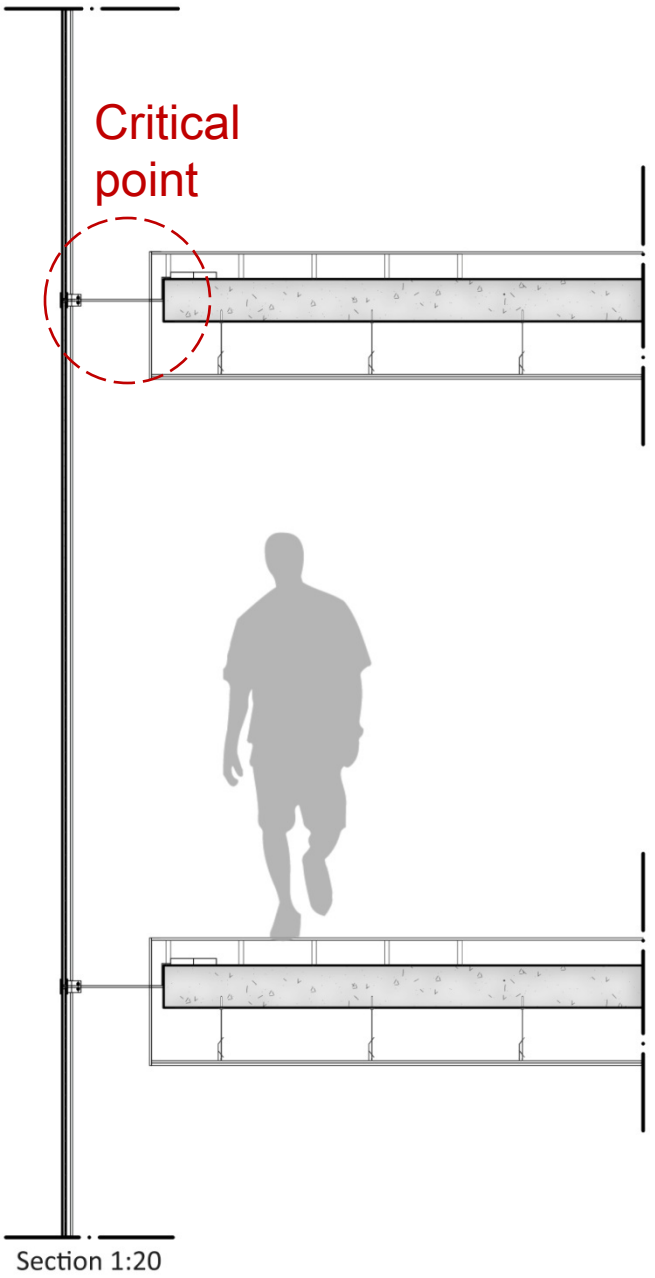
• Spider glazing is used to **minimize** dimensions of panels while here are 1,5 x 3 m

• This façade system allows **deformation** up to 50mm so cables on the slab will be damaged

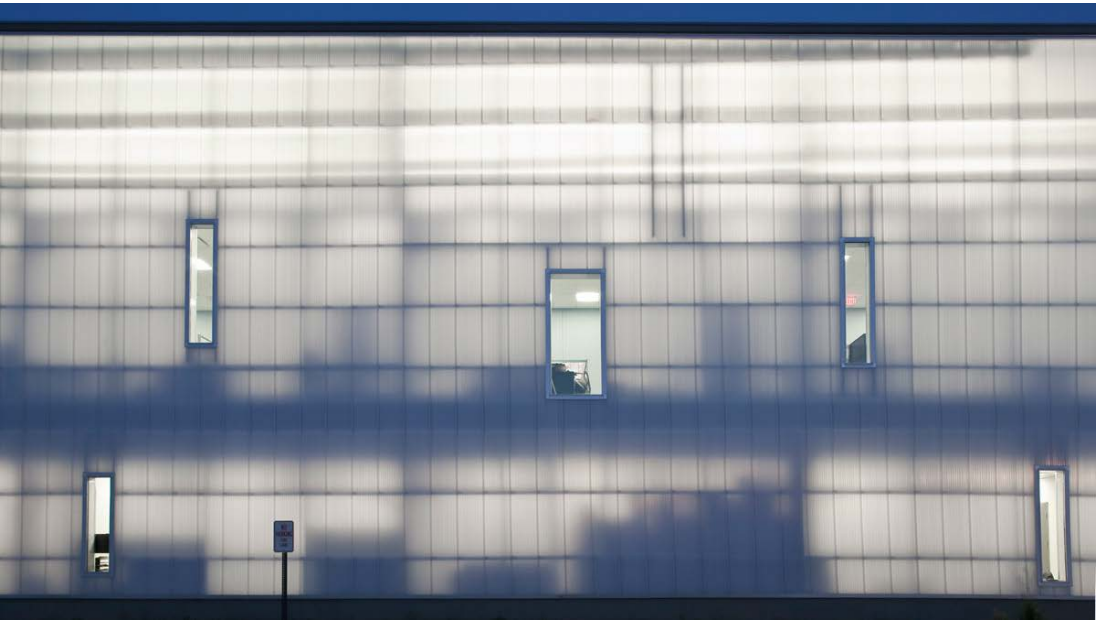
• **Maintenance** issues for the LEDs (whole panel needs to be changed)

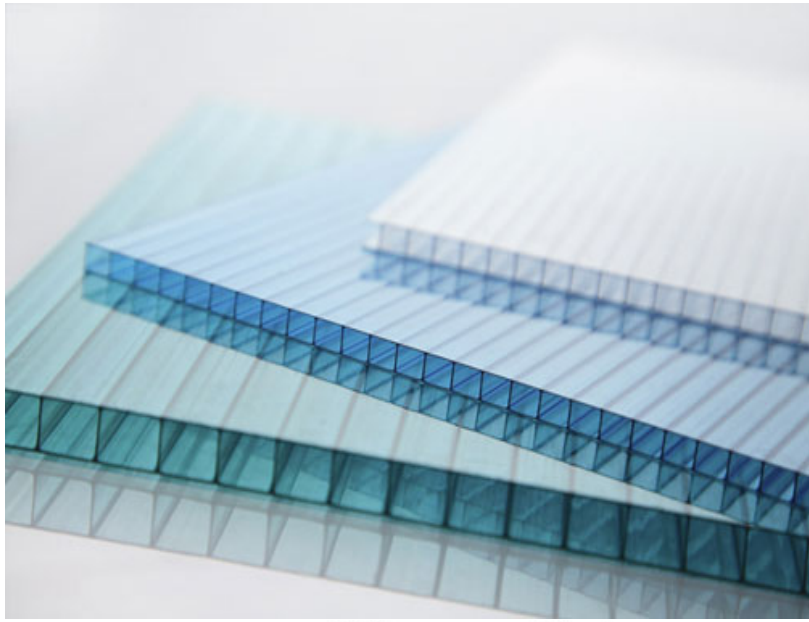
• No **sun shading** integrated

• **Limitation** in pixel pitch with the intermediate mullions



Second part of the research(**Polycarbonate structural sheets**)

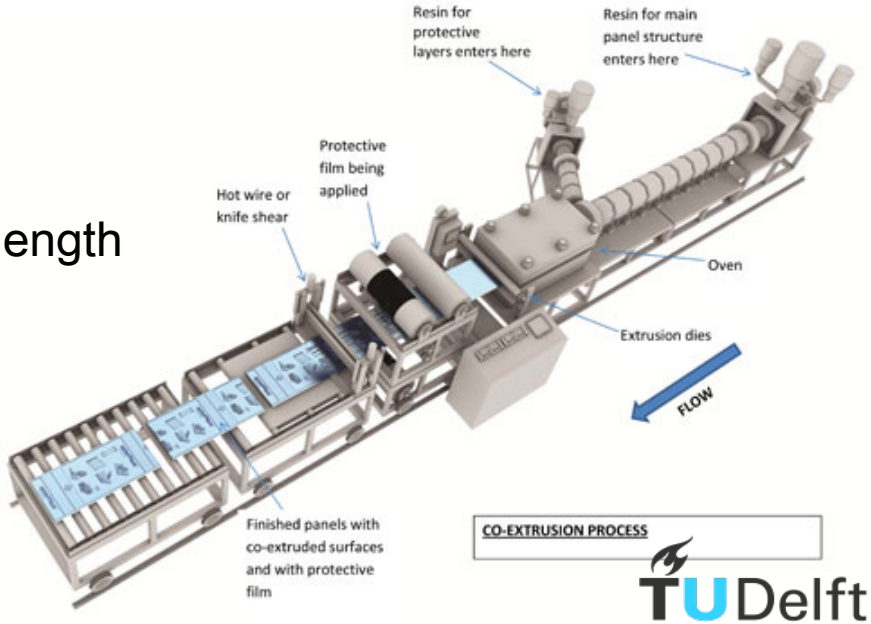




Polymers containing carbonate groups

Production: extrusion technology up to 30 m length

- impact resistance
- optical properties
- temperature and fire resistance



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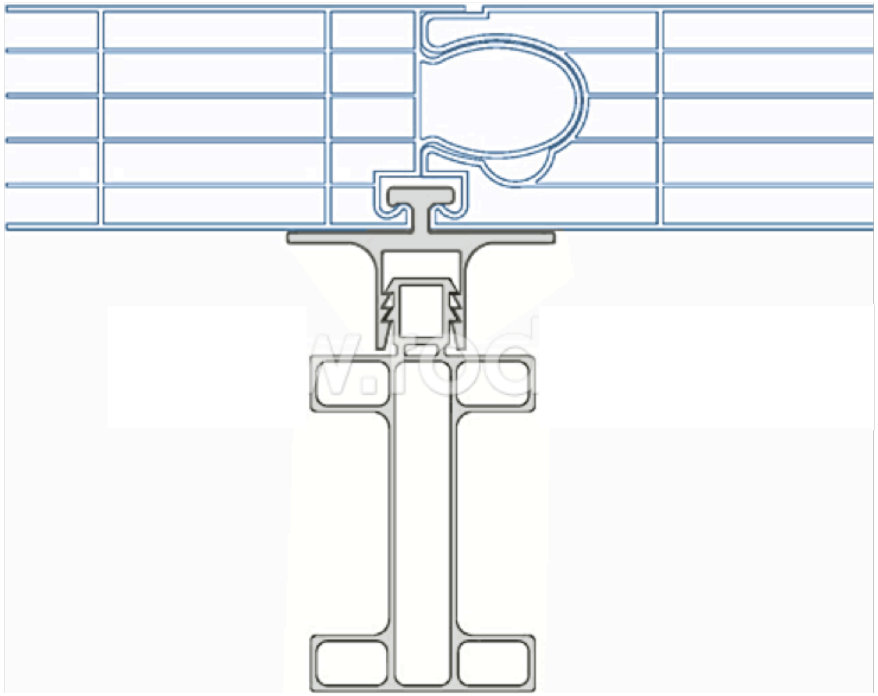
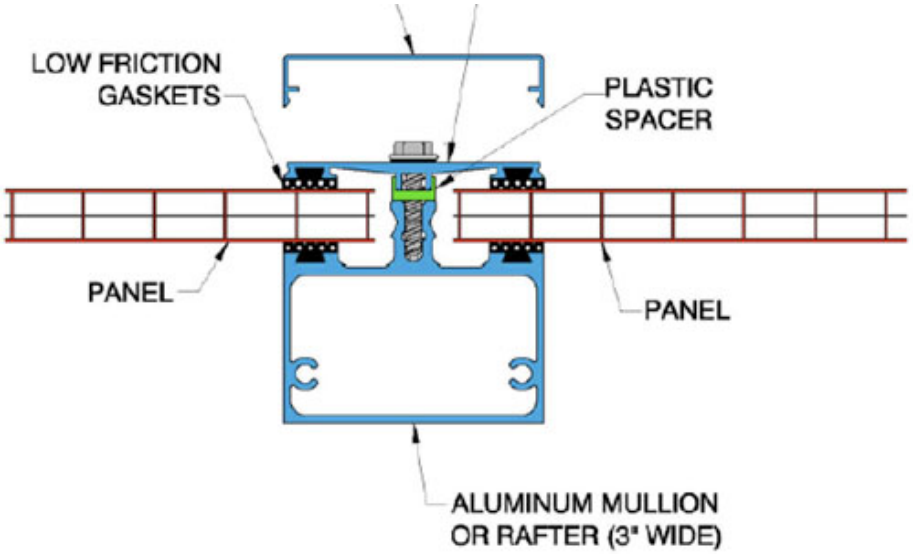
Multiwall systems

- Click system
- Curtain wall
- Several thickness
- Versatility for any facade
- Colour variety





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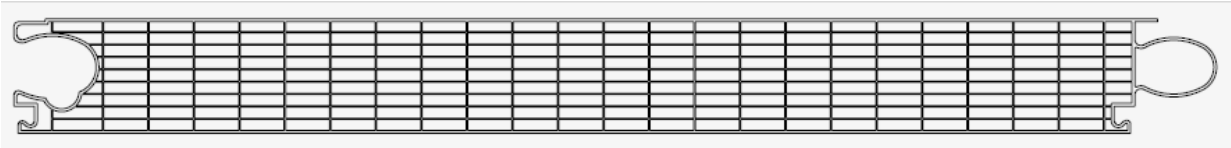
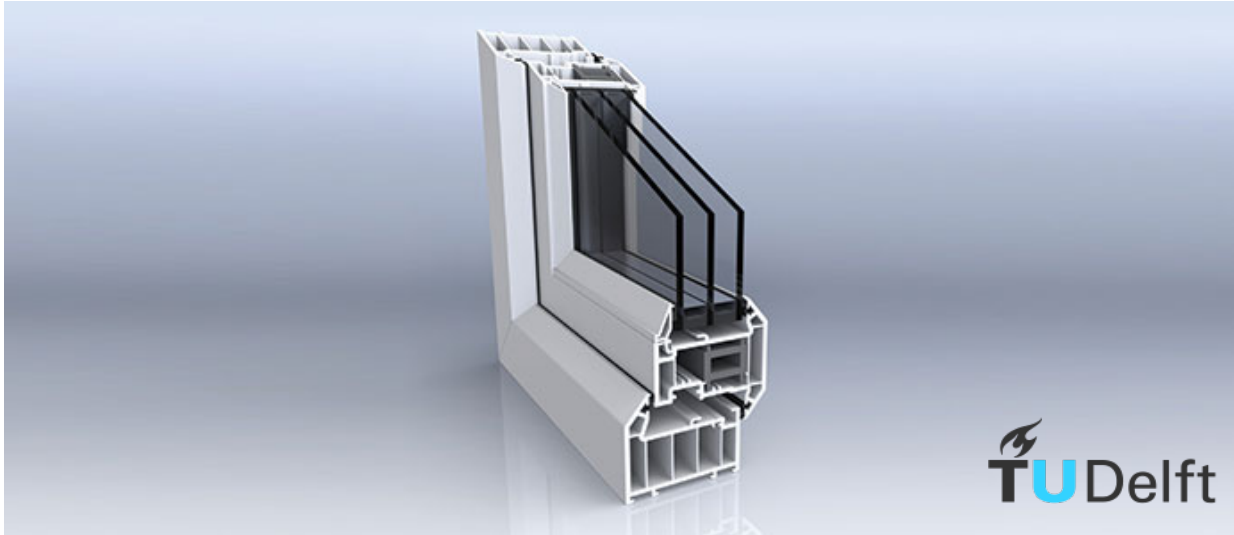
PCSS vs Glass

- **Brittle resistance** 20 times more
- **Ultimate strength** 2 times more
- Better **thermal resistance** (U-value up to 0.83 – like triple glazed with argon and low-e coatings
- **Lighter weight** 10 times
- **Cold bending**
- **Cheaper** solution
- Light and **simple framing**

		Polycarbonate PC	Glass
Mechanical Properties			
Density (ρ)	Mg/m^3	1.14-1.21	2.44-2.5
E-modulus (E)	GPa	2.21-2.44	68-72
Poison's Ratio (ν)	dimensionless	0.38-0.42	0.2
Yield Strength (σ_y)	MPa	58.6 - 70.0	31-35
Ultimate Strength (σ_{ult})	MPa	65.0 - 72.4	31-35
Elongation at yield	%	6.00 - 50.0	0
Elongation at break	%	10.0 - 125	0





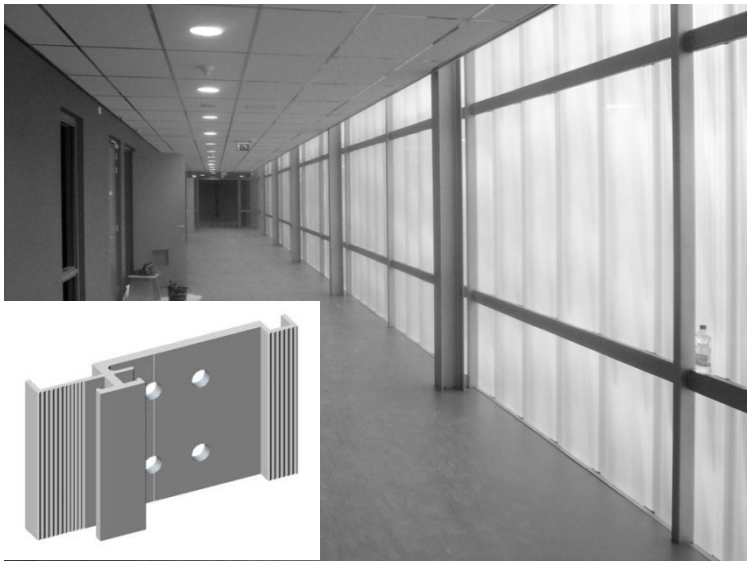
Glass vs PCSS

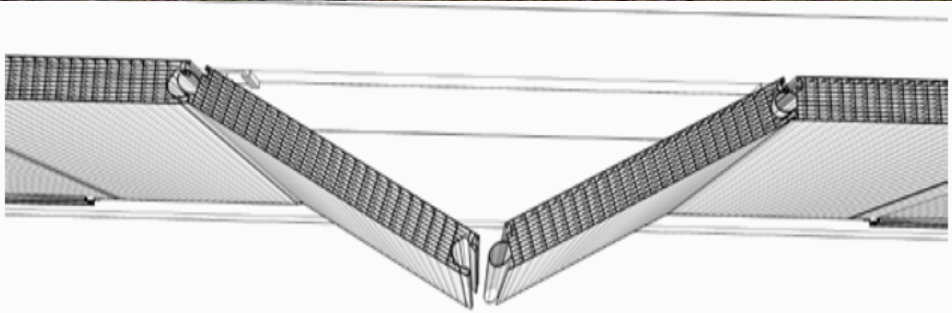
- **Transparency**
- Better **fire resistance** and **lifespan**

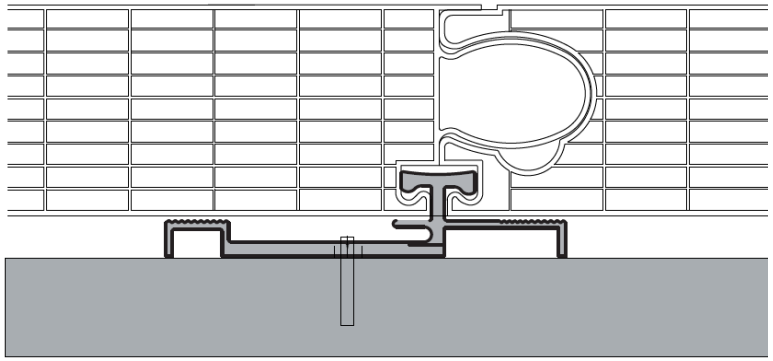
(Softening point 600°C)

- **Less deformation** so better Young's modulus

PCSS Reference projects







- Filter selection for walls
- Under structure
- Quicker and easiest installation for maintenance

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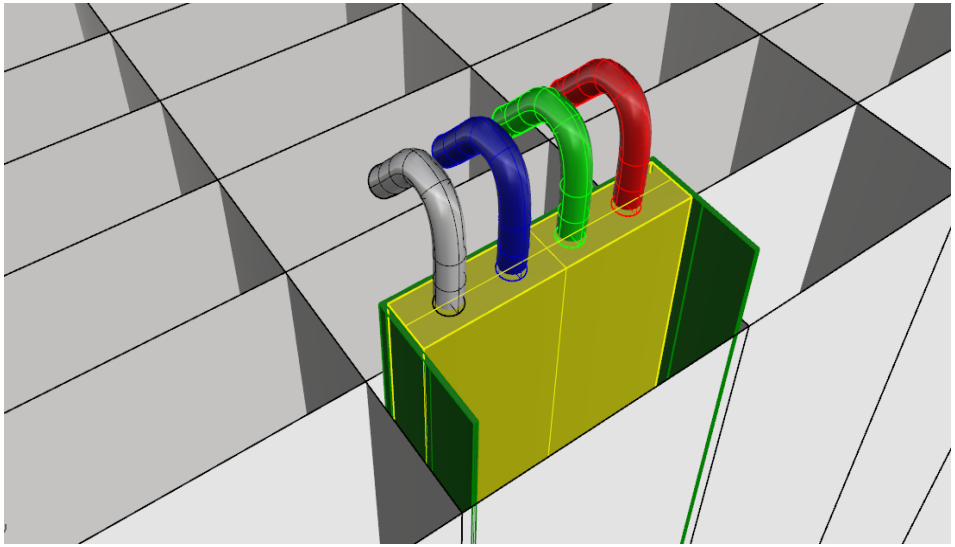
Design stage (**polycarbonate & LEDs**)

- Same product **lifespan** (10 years PCSS and 12 hours per day for LEDs)
- **Pixel pitch variety** starting from12 mm
- **Temperature** checks for the combination
- Easy separation for **reuse** (polycarbonate is a thermoplastic and LEDs can be recycled)



Pixel pitch (mm)	Minimum viewing distance(m) Multiply by 1400 mm
12	17
25	35
35	50
50	70
65	90
80	115
95	135

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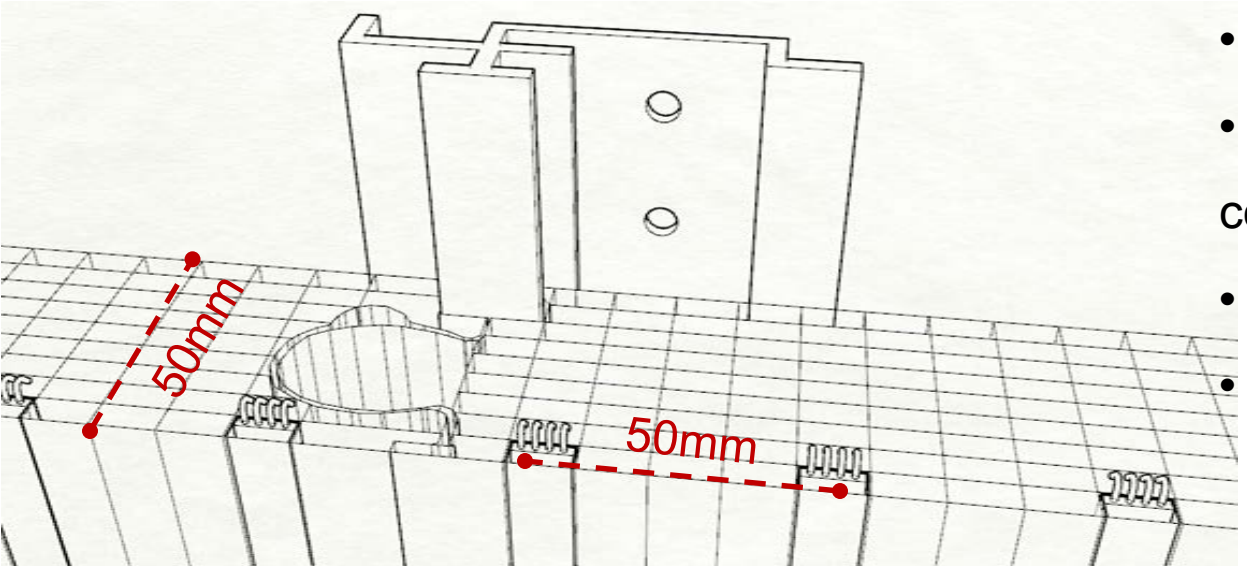
1st design

- 50 mm pixel pitch
- 5.600 nits
- Media facade for a raised shopping mall
- Example in Delft central square for distances



- Click fix system
- 50 mm thickness (most commonly used)1 x 9 m
- U value 0,83 W/m^{2}K
- Led strips every 4th chamber

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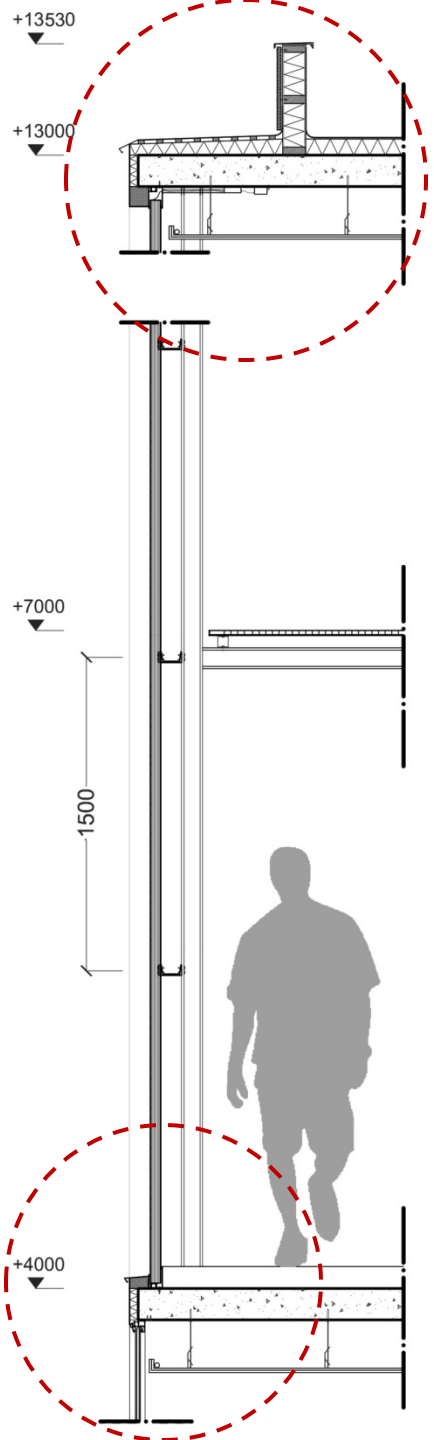
+13530
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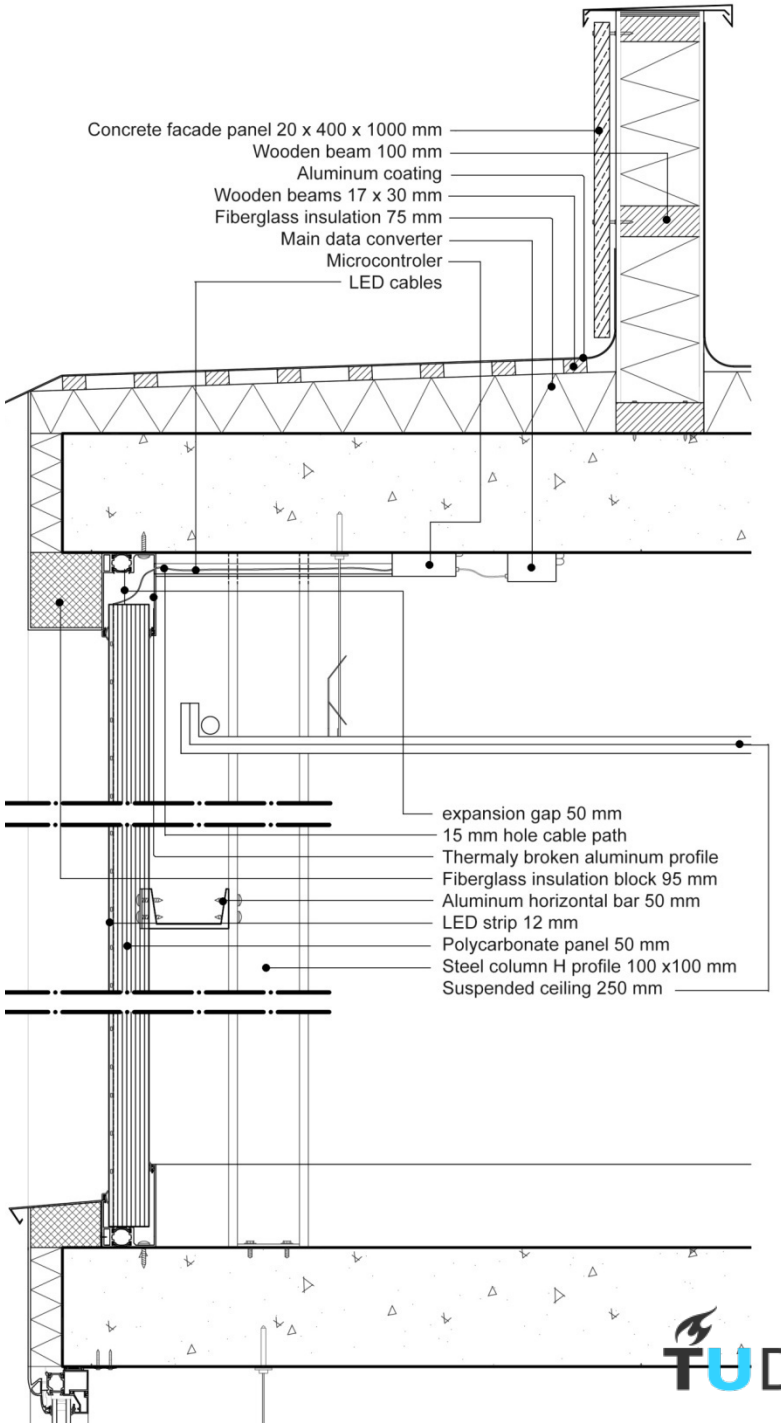
+4000


Concrete facade panel 20 x 400 x 1000 mm
Wooden beam 100 mm
Aluminum coating
Wooden beams 17 x 30 mm
Fiberglass insulation 75 mm
Main data converter
Microcontroler
LED cables
expansion gap 50 mm
15 mm hole cable path
Thermaly broken aluminum profile
Fiberglass insulation block 95 mm
Aluminum horizontal bar 50 mm
LED strip 12 mm
Polycarbonate panel 50 mm
Steel column H profile 100 x100 mm
Suspended ceiling 250 mm

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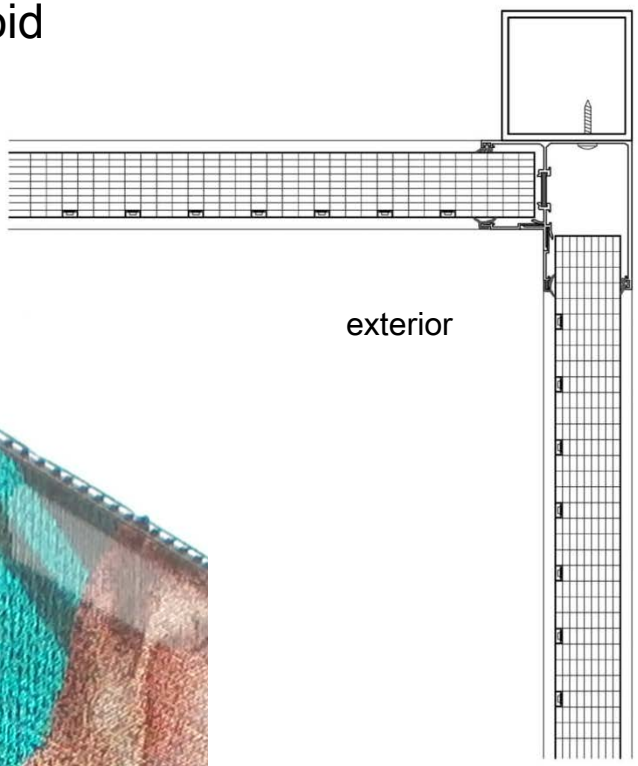
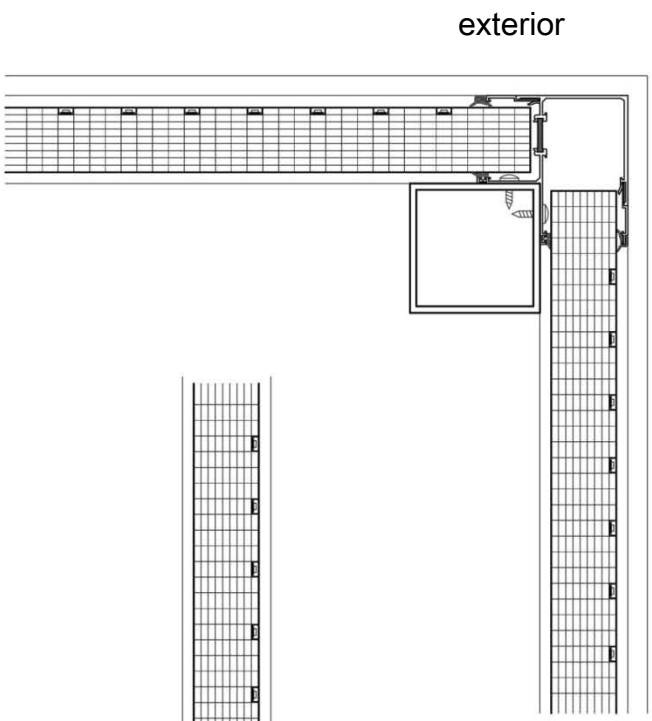
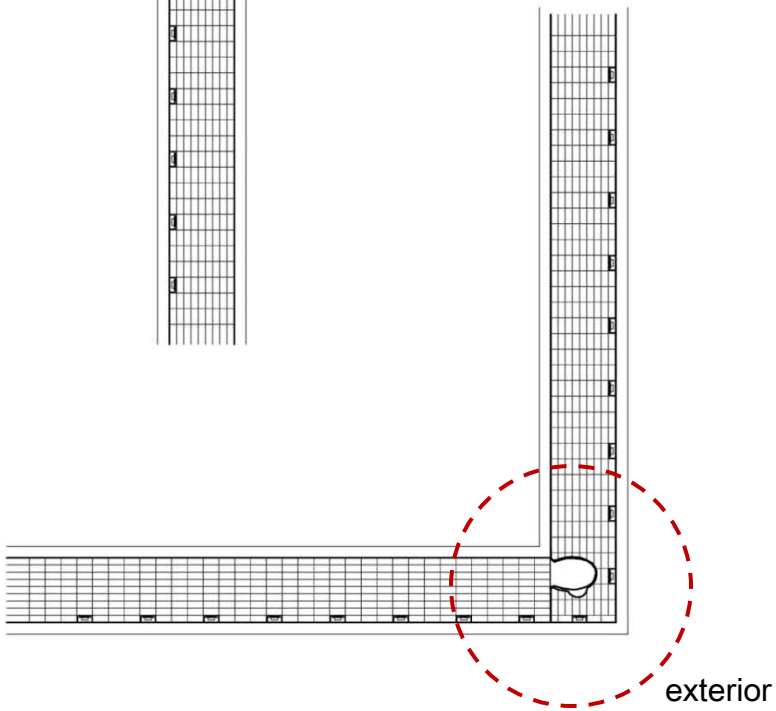
Corner details to avoid interruption of image







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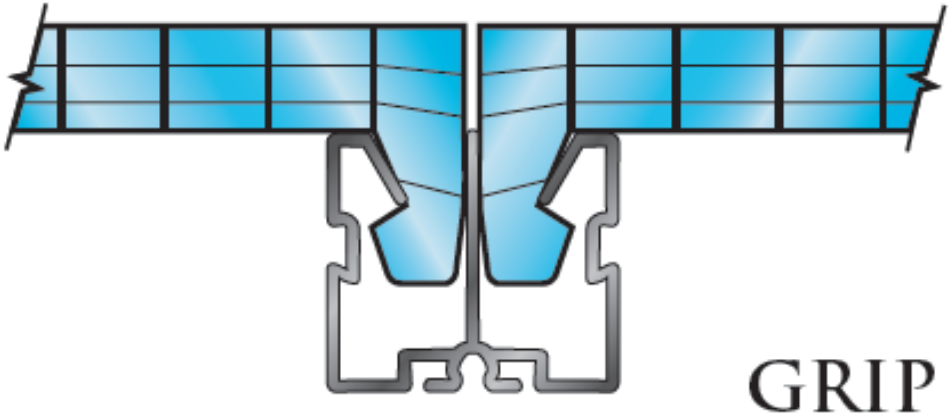
2nd design

- 25 mm pixel pitch
- 22.400 nits
- Curved media facade for a public building 5 x 18 m
- 25mm thickness PCSS 1 x 18 m
- Example in Delft City Hall
- Grip locked system



GRIP

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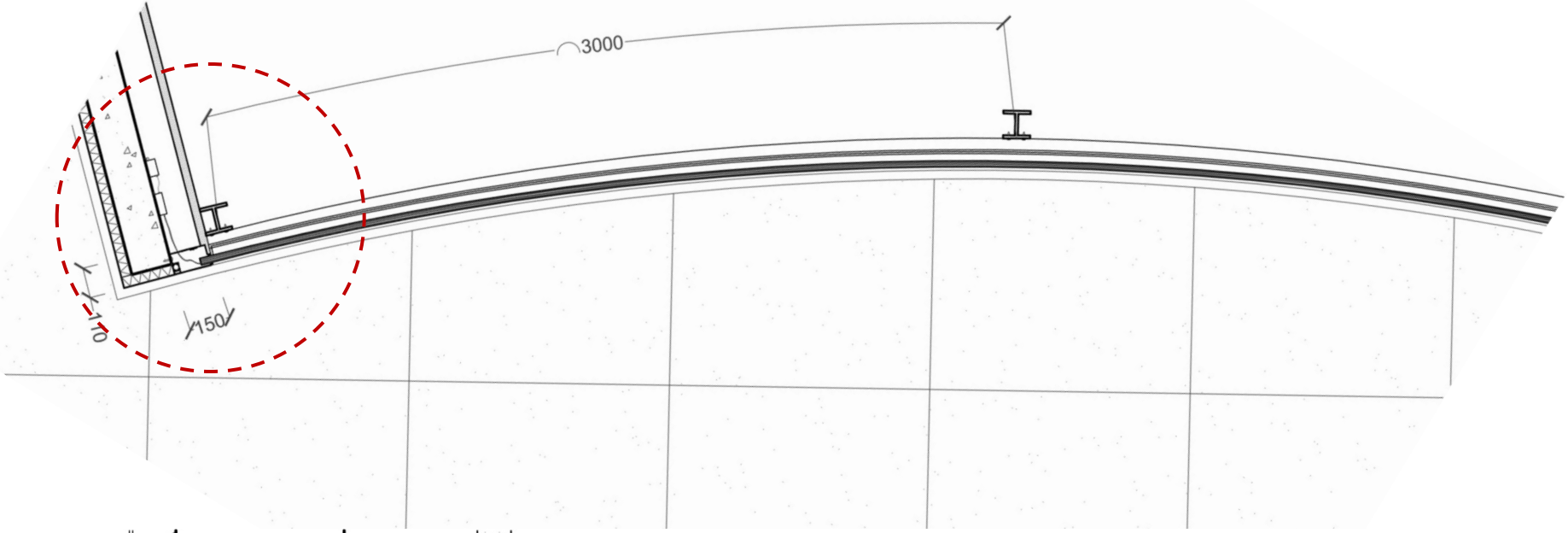
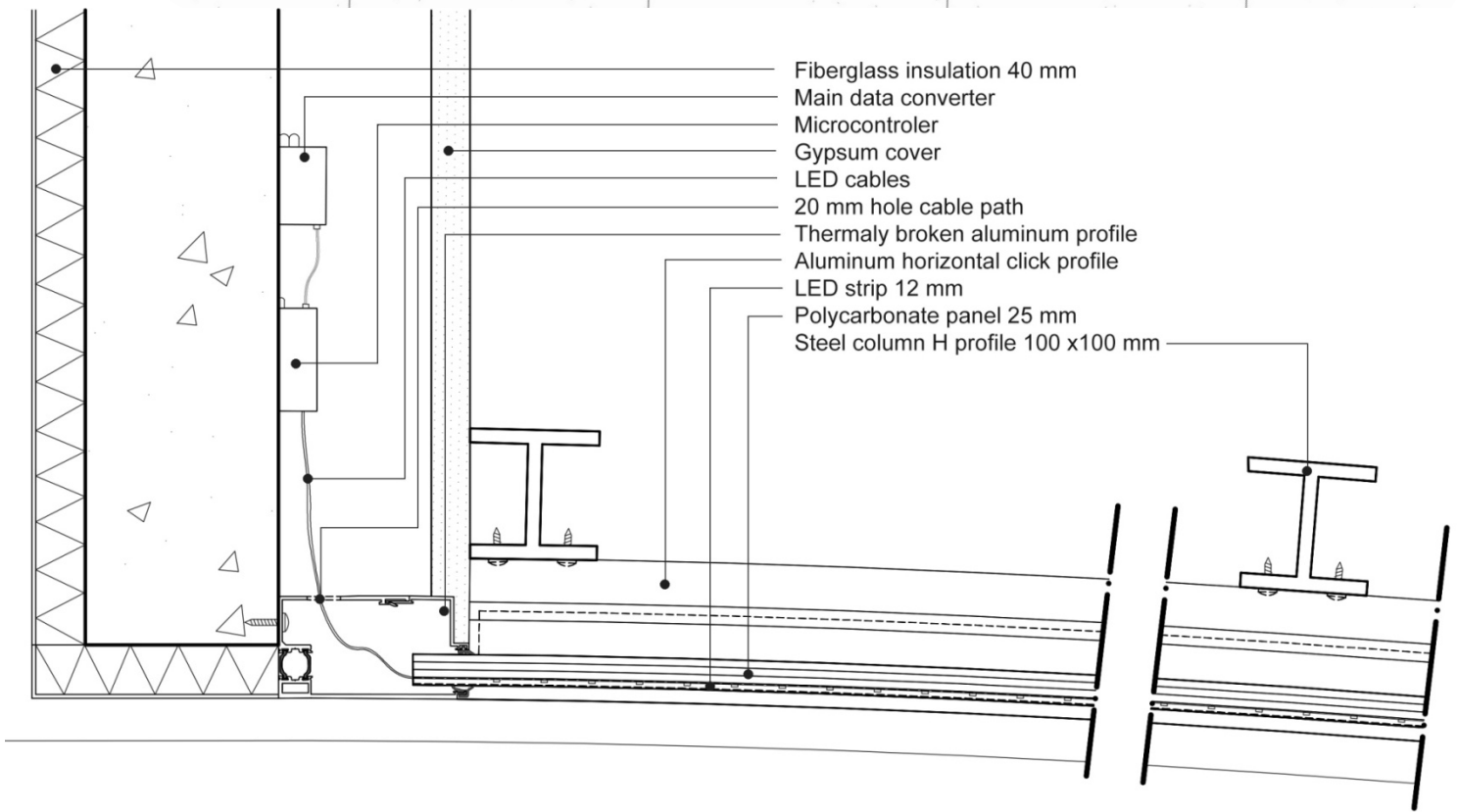

3000
150
10


Fiberglass insulation 40 mm
Main data converter
Microcontroler
Gypsum cover
LED cables
20 mm hole cable path
Thermaly broken aluminum profile
Aluminum horizontal click profile
LED strip 12 mm
Polycarbonate panel 25 mm
Steel column H profile 100 x100 mm

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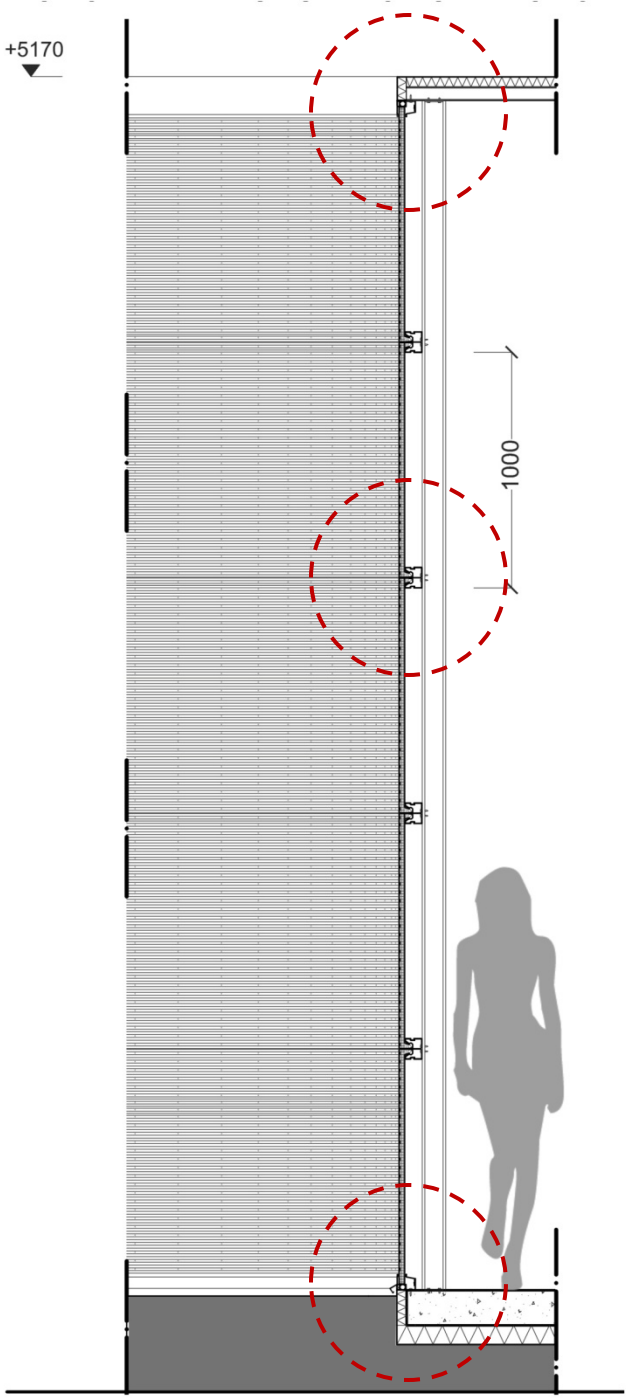
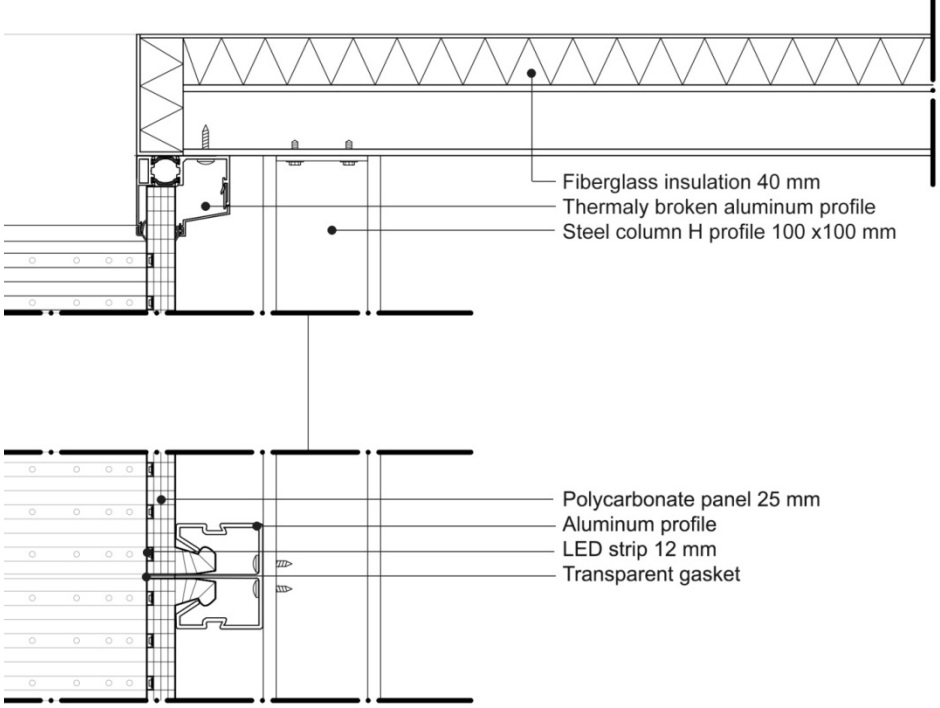
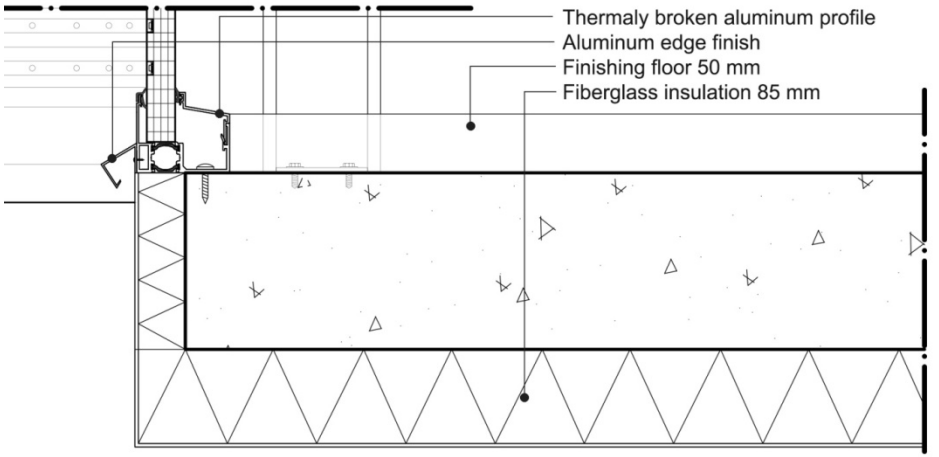

+5170
1000


Fiberglass insulation 40 mm
Thermaly broken aluminum profile
Steel column H profile 100 x100 mm
Polycarbonate panel 25 mm
Aluminum profile
LED strip 12 mm
Transparent gasket


Thermaly broken aluminum profile
Aluminum edge finish
Finishing floor 50 mm
Fiberglass insulation 85 mm

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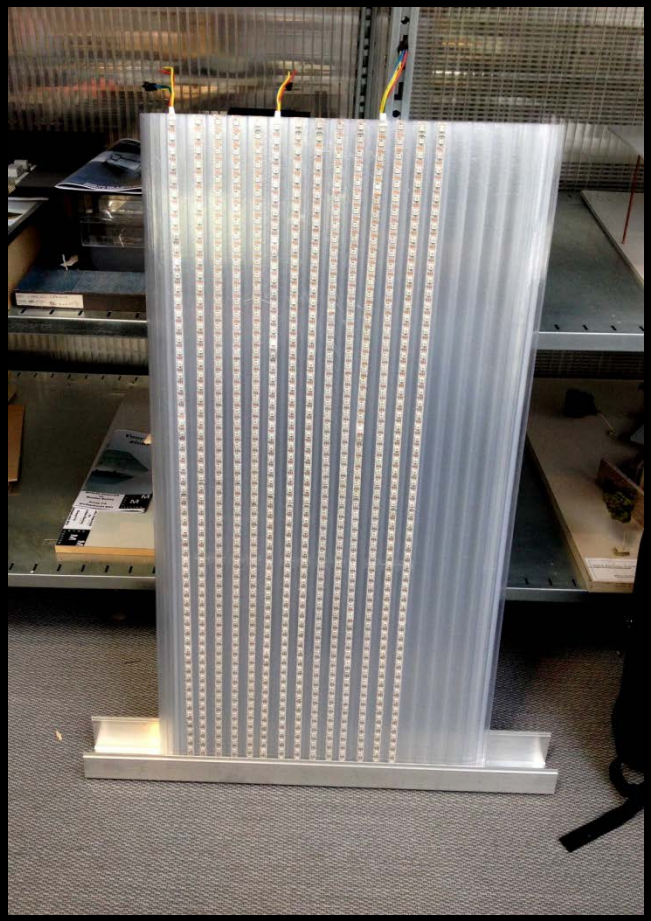
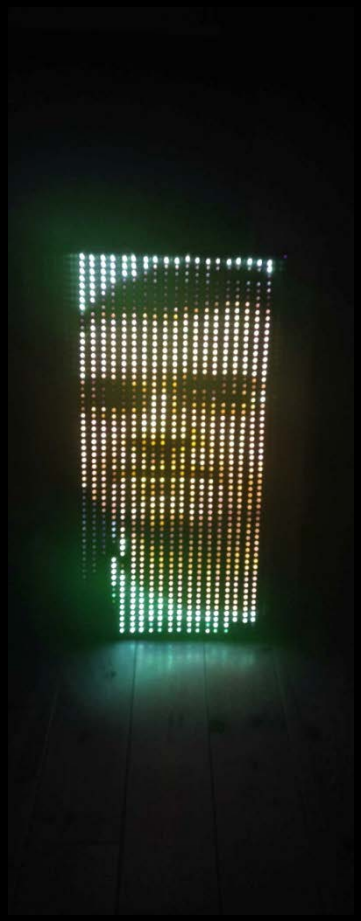
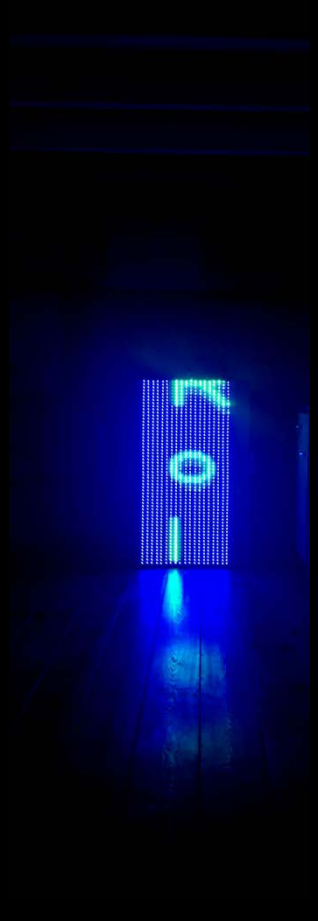
Mock up







Minimum viewing distance needs to be higher than suggested by companies

Museum of energy Spain
25 mm pixel pitch from 30 m viewing distance-afternoon

Piccadilly Circus London
25 mm pixel pitch from 30 m viewing distance

TU Delft

Rollecate warehouse day
25 mm pixel pitch from 35 m viewing distance with direct sunlight

TU Delft

Rollecate warehouse night
25 mm pixel pitch from 35 m viewing distance

Evaluation

Initial standards

- **Light transmission** 72-50% but not 95% like glass
- **Good quality graphics** by easily adjusting pixel pitch variety >12 mm
- **Cost effective** solution (8 times cheaper than Philips and 35% less cost for a 25 mm than Brakel Atmos)-(10 and 8 times cheaper than GKD and Leurocom)
- **Maintenance** (LEDs are independent from PCSS, no lamination process or special enclosure)
- Use in **day** and **night** (above 50 mm pixel pitch sunlight affects the quality)

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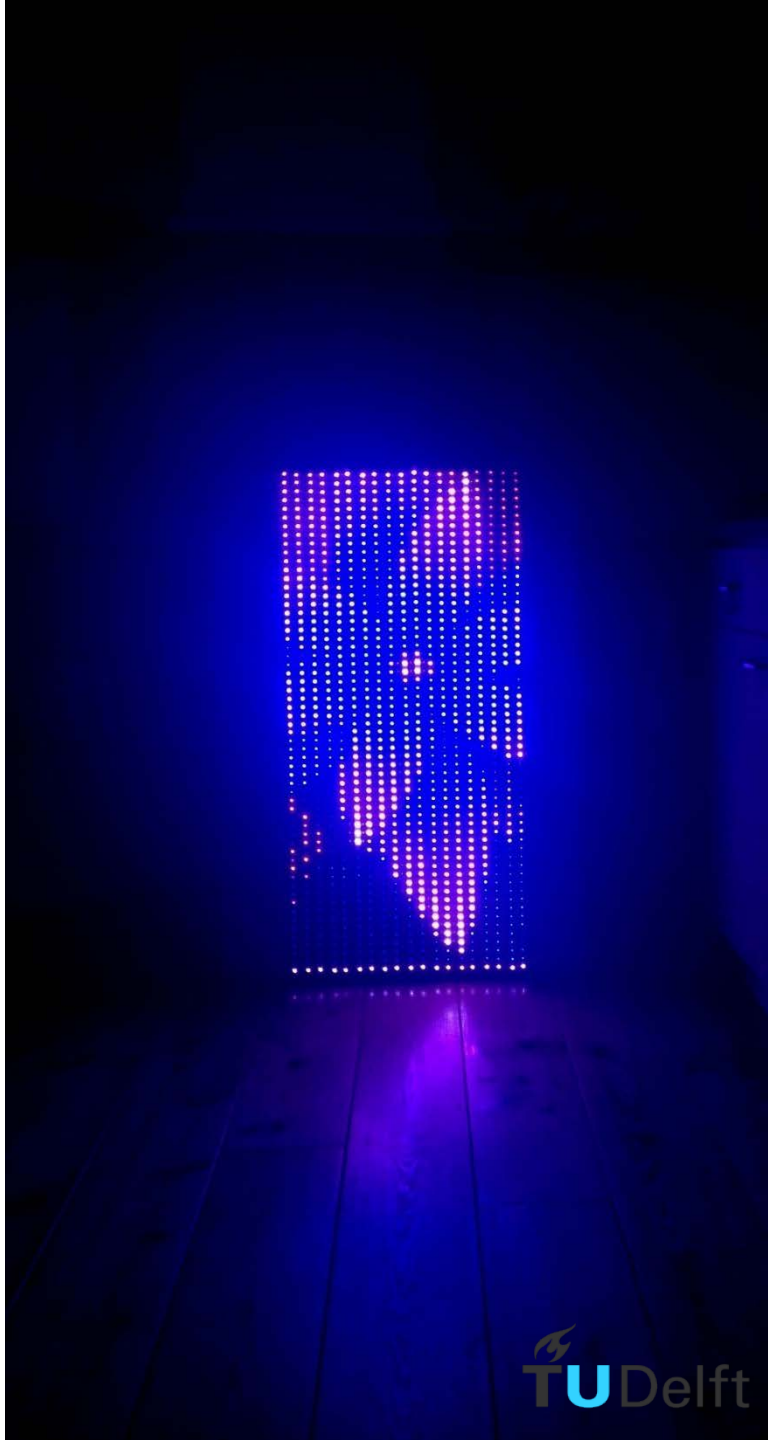
Evaluation

- **Limited life** of polycarbonate material and affected by the time (degradation and softening although the UV protection)

- Cannot be applicable in high rise buildings due to strong **wind loads** and pressures on the material

- Not applicable in **hot climates** in combination with the LEDs temperature emission

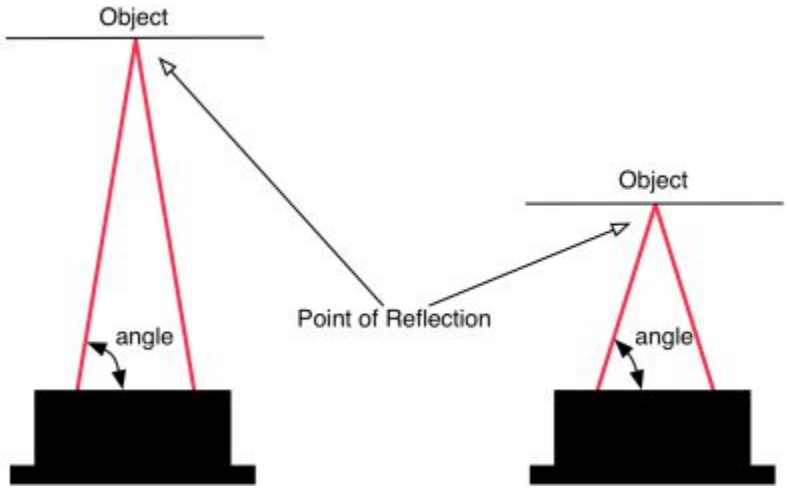
- **Sample** of 1:1 necessary and the distances increased

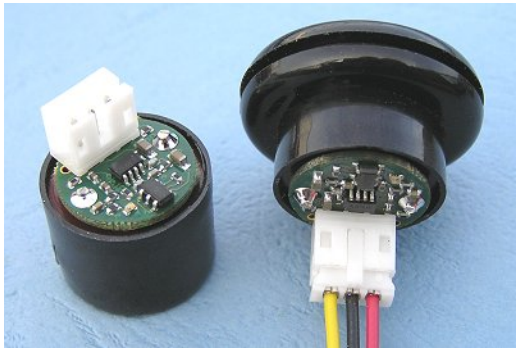


Further steps

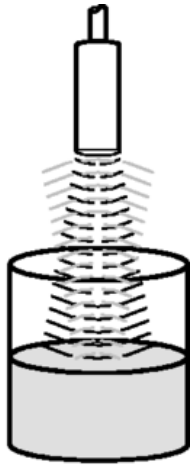
- **Interactive** LED facade using motion or pressure sensors (passing train)

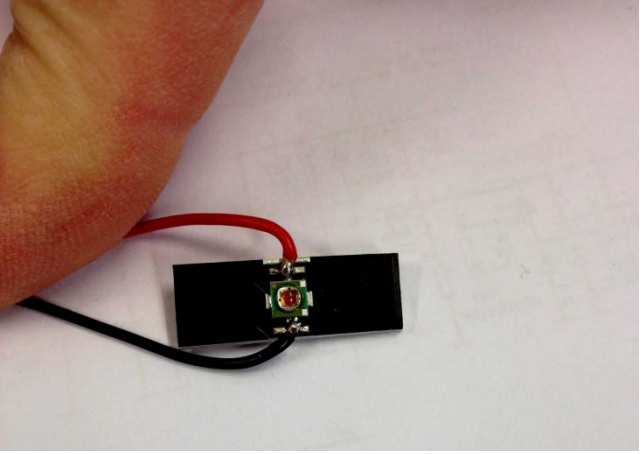
IR sensors(usually<1m)

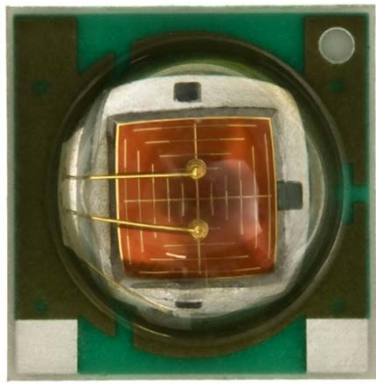




Ultrasonic sensors
6-10 m easily



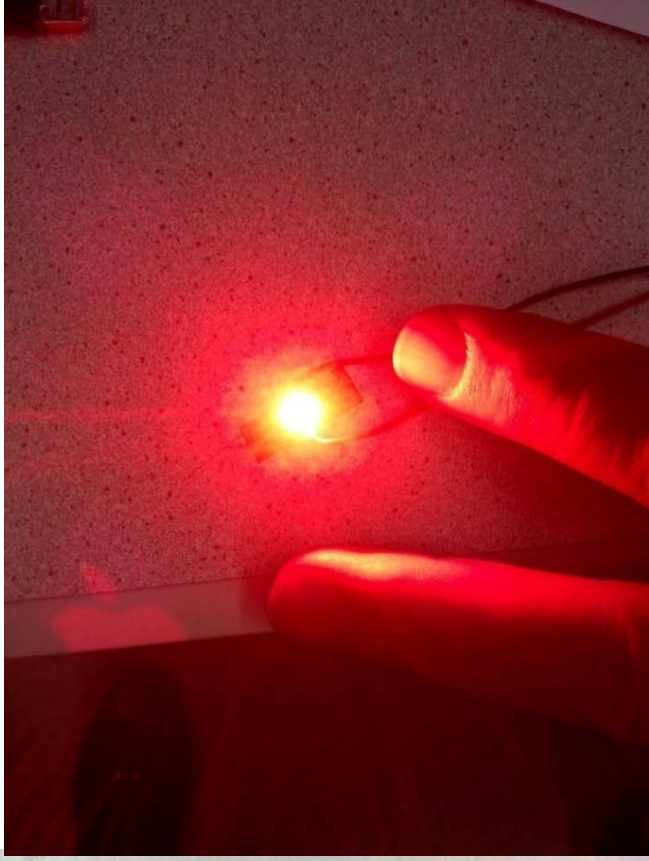




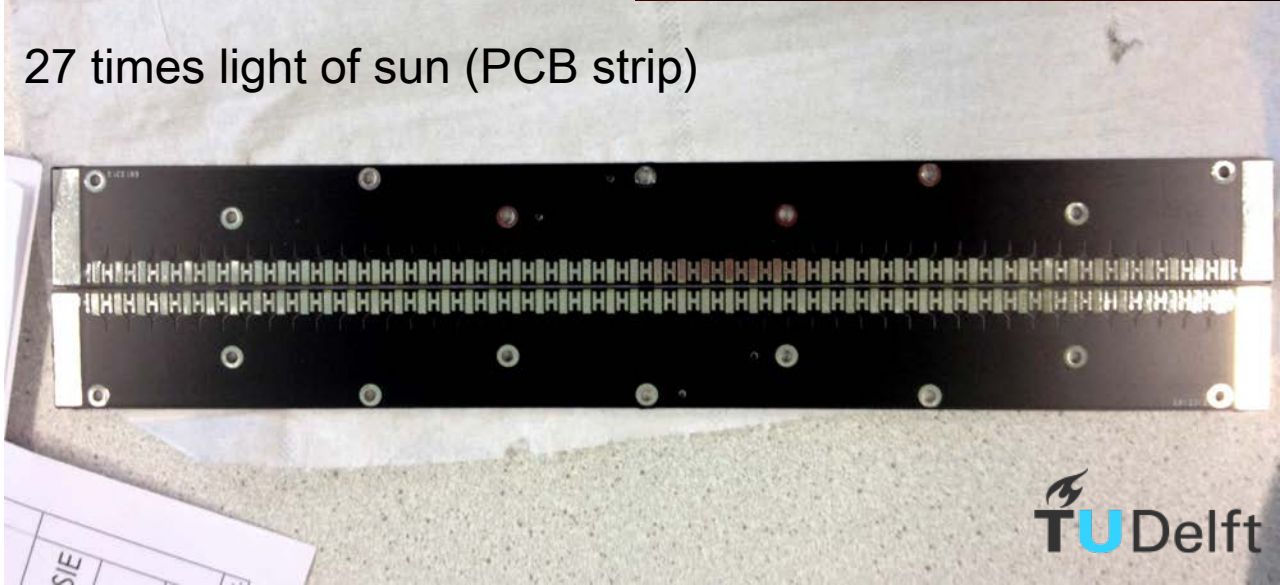
XLamp® XP-e LeD

Possible application for better performance with direct sunlight in a media facade

7 times light of sun(PCB)



27 times light of sun (PCB strip)



Future potential

Thank you

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Transparent Building Materials

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