

# Development of a Rotatable Outdoor Testbed and the Testing of an Integrated Auto-dimming Lighting and Automated Blind System in the Tropics

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# Introduction



Organisers:



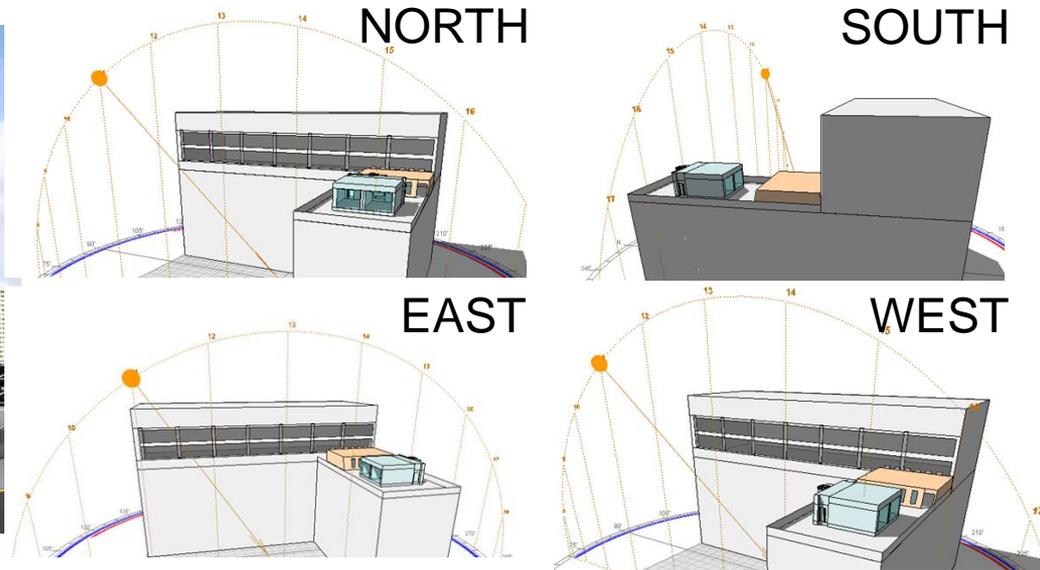
International Co-owners:



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# The BCA SkyLab Facility



An outdoor test bed built on a 360° rotatable platform

- Allows test bedding under different solar orientations
- Side-by-side test compartments for comparative studies
- Comprehensive sensor network and instrumentation



Organisers:



International Co-owners:



# Test bed capabilities



Automated blinds



Chilled Beam system  
and DC motor FCU



LED lights with daylight  
control



Electrochromic façade and  
Double pane low-e glass

Two side-by-side test chambers provide plug-and-playability to test –

- Lighting
- Blinds
- Façade
- ACMV system
- Integrated system

# Methodology



Organisers:



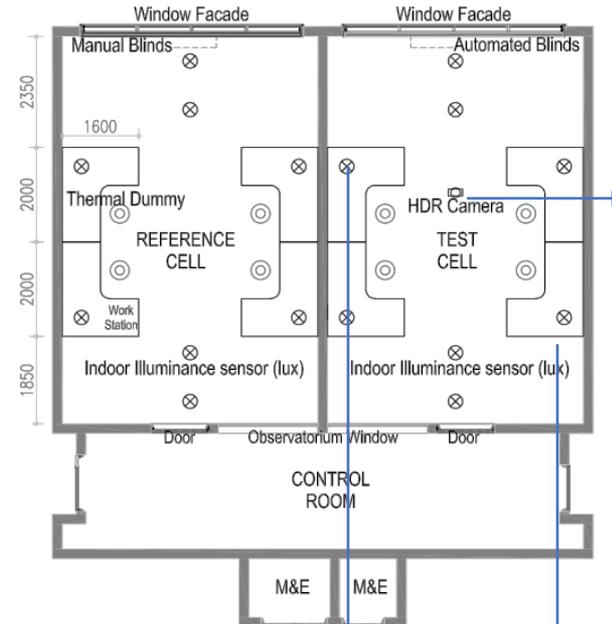
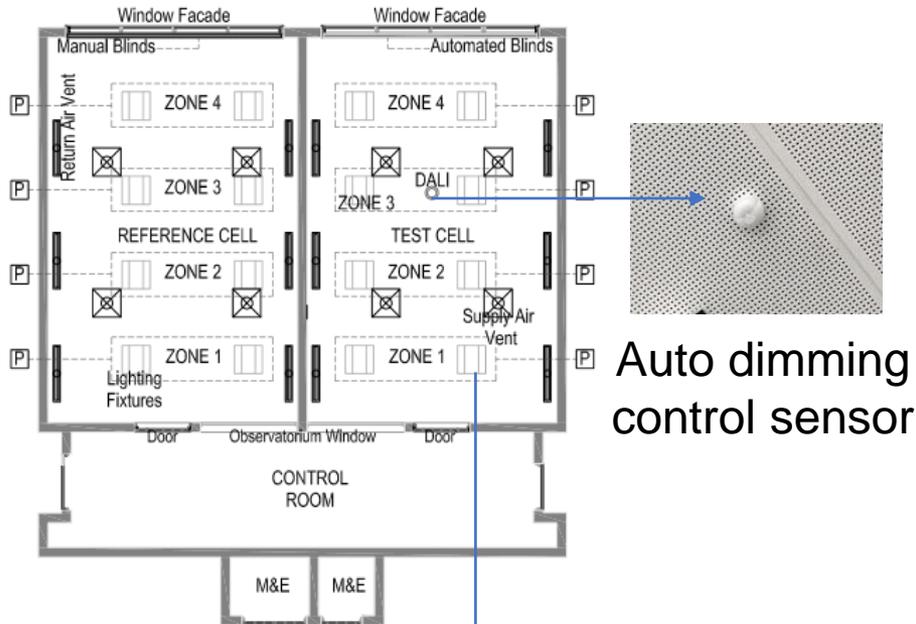
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# Experiment set up



HDR camera



T5 Fluorescent Lighting



LED Lighting



Lux sensor range 150,000 Lux



Lux sensor range 10,000 Lux

# Auto-dimming and auto blinds

**Automated daylighting control**  
based on Singapore weather condition.

50mm venetian  
mirrored blind  
Reflectivity = 0.91



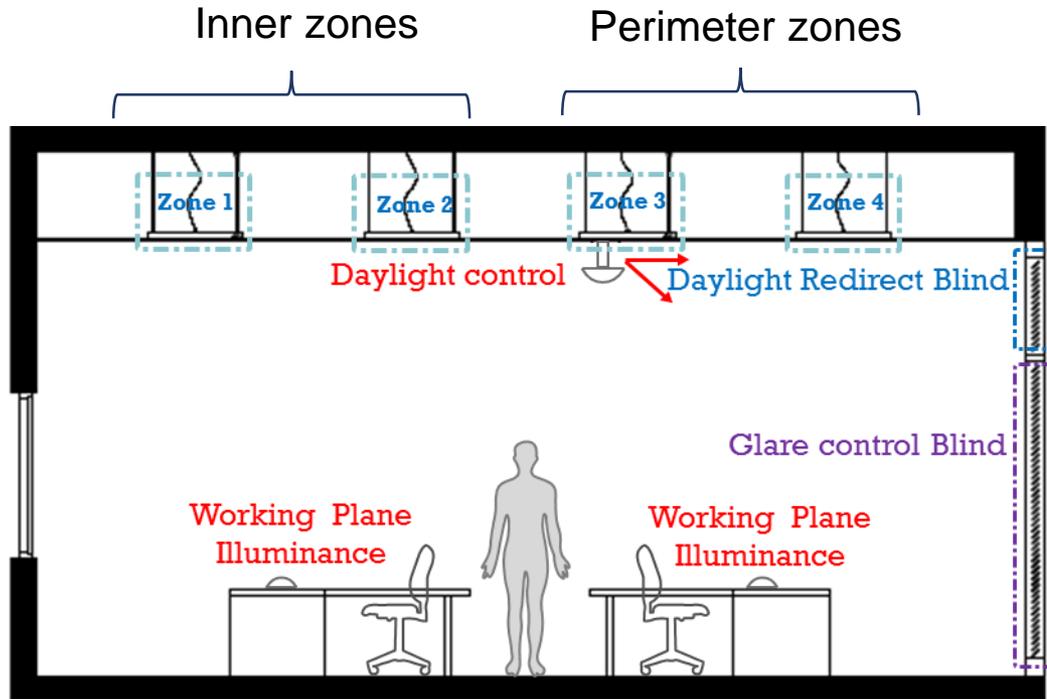
25mm venetian blind  
Reflectivity = 0.56



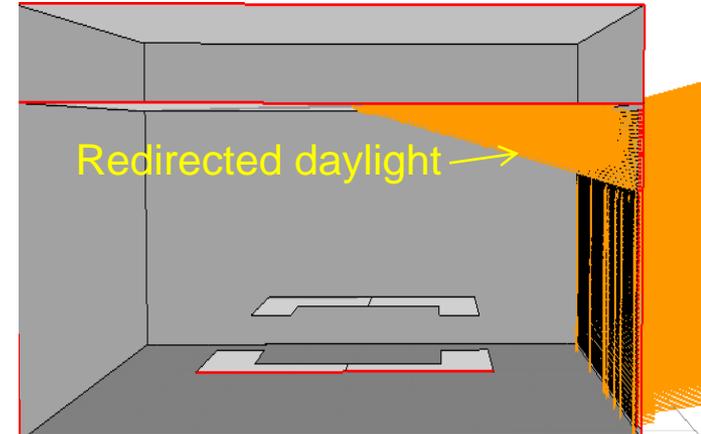
Auto  
blinds

# Auto-dimming and auto blinds

**Auto dimming lighting control** system to achieve good working plane illuminance and energy savings.



Zonal auto-dimming control in response to daylighting condition



Daylight redirection simulation



Auto blinds and dimming control dashboard

# Test cases

Tests	Reference Cell	Test Cell	Façade Orientation
<b>Test 1</b> <b>Whether auto-dimming saves energy?</b>	Lighting: T5 fluorescent Auto-dimming: No Blinds: Retracted	Lighting: T5 fluorescent Auto-dimming: Yes Blinds: Retracted	North
<b>Test 2</b> <b>Whether LED + auto-dimming saves energy?</b>	Lighting: T5 fluorescent Auto-dimming: Yes Blinds: Retracted	Lighting: LED Auto-dimming: Yes Blinds: Retracted	North
<b>Test 3</b> <b>Whether LED + auto-dimming + auto blinds save energy?</b>	Lighting: T5 fluorescent Auto-dimming: No Blinds: Close	Lighting: LED Auto-dimming: Yes Blinds: Automated	North
<b>Test 4</b> <b>Impact of orientation on LED + auto-dimming + auto blinds</b>	Lighting: T5 fluorescent Auto-dimming: No Blinds: Close	Lighting: LED Auto-dimming: Yes Blinds: Automated	East

# Results



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International Co-owners:



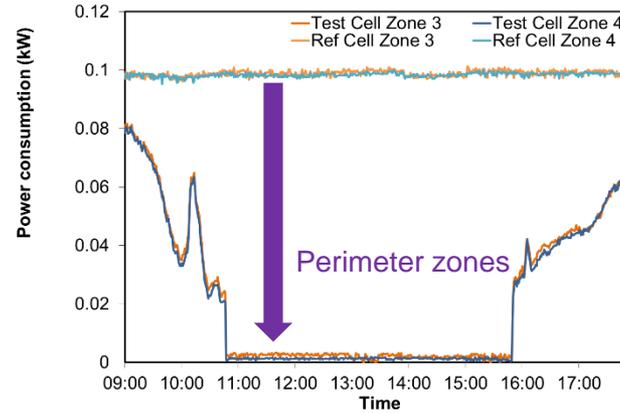
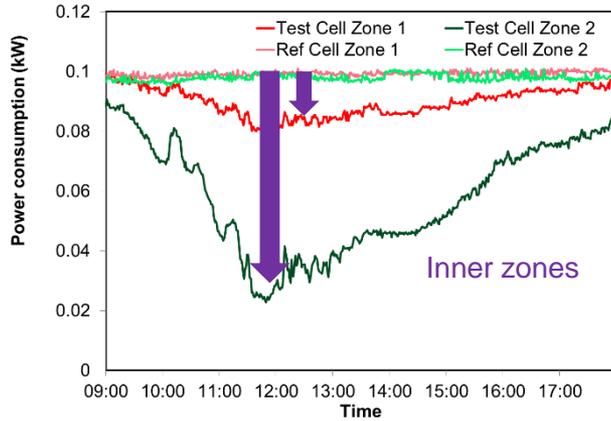
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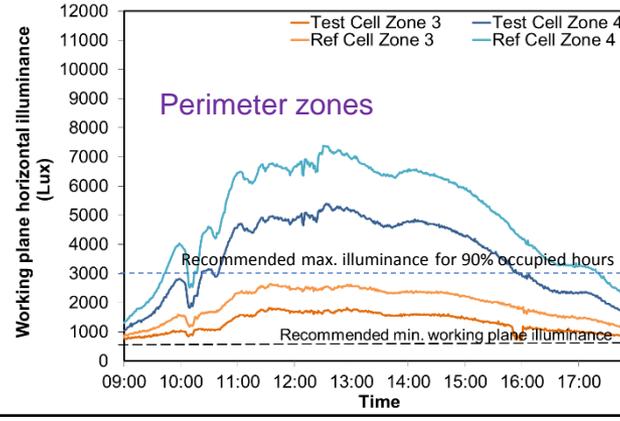
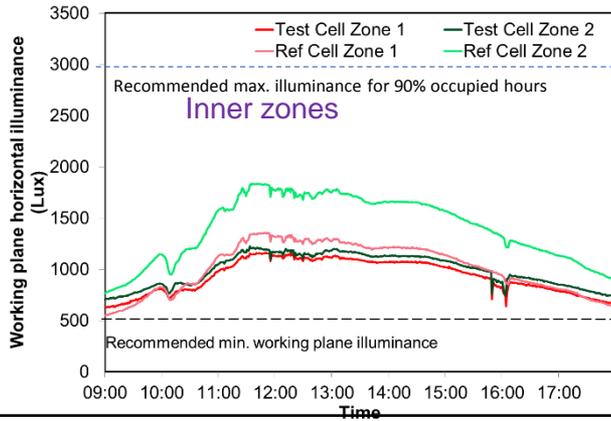
# No-dimming (T5) vs Auto-dimming (T5)

Lighting energy savings

Working plane illumination



Whole-cell lighting energy savings up to **47%**



Working plane illumination level > **500 Lux\***

Perimeter zone exceed **3000 Lux\*\***

Lighting Energy Reference Cell <i>T5, No Auto-dimming Retracted blinds</i>	Lighting Energy Test Cell <i>T5, Auto-dimming Retracted blinds</i>	Lighting Energy Savings (kWh) <i>Contribution of Auto-dimming</i>	Lighting Energy Savings (%) <i>Contribution of Auto-dimming</i>
10.47 kWh	5.51 kWh	4.96 kWh	47.37 %

\*SS531: Part1: 2006 (2013)

\*\*Green Mark NRB2015 Technical Guide Requirements



Organisers:



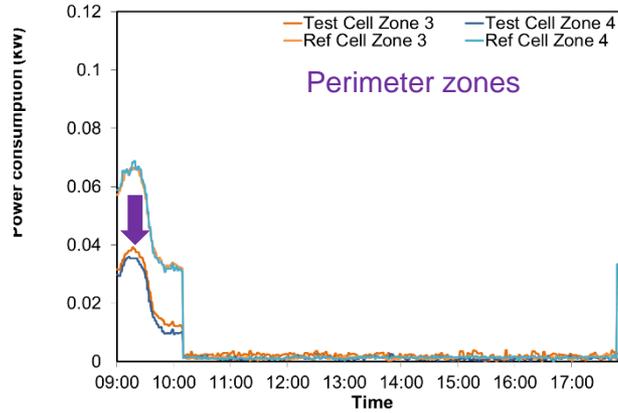
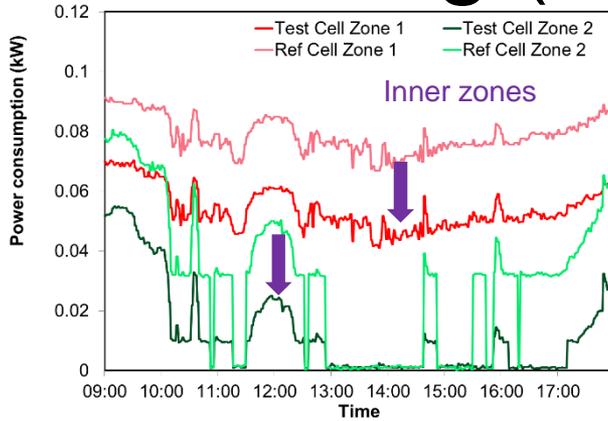
International Co-owners:



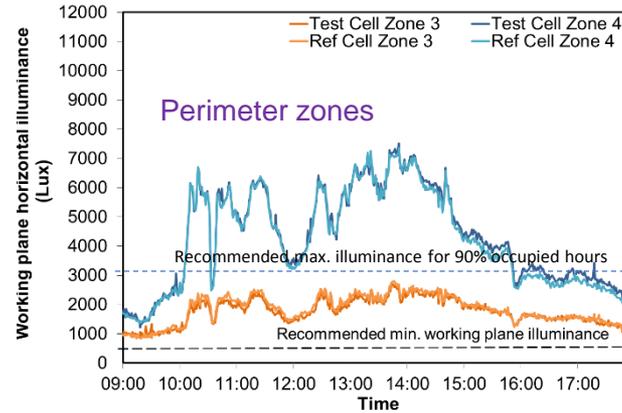
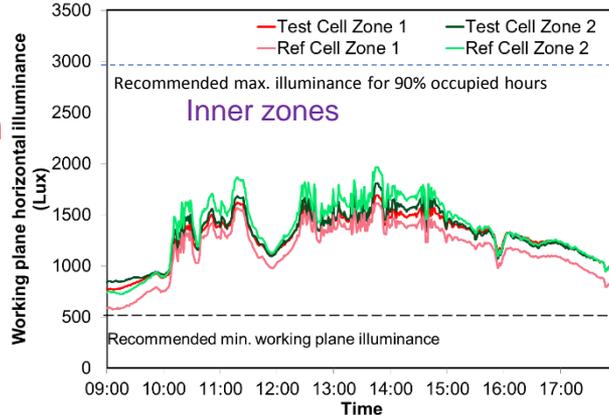
# Auto-dimming (T5 vs LED)

Lighting energy savings

Working plane illumination



Whole-cell lighting energy savings up to **42%**



Working plane illumination level > **500 Lux\***

Perimeter zone exceed **3000 Lux\*\***

Lighting Energy Reference Cell  
**T5, Auto-dimming Retracted blinds**

Lighting Energy Test Cell  
**LED, Auto-dimming Retracted blinds**

Lighting Energy Savings  
**Contribution of LED and Auto-dimming**

Lighting Energy Savings  
**Contribution of LED and Auto-dimming**

3.52 kWh

2.06 kWh

1.46 kWh

41.52 %

\*SS531: Part1: 2006 (2013)

\*\*Green Mark NRB2015 Technical Guide Requirements



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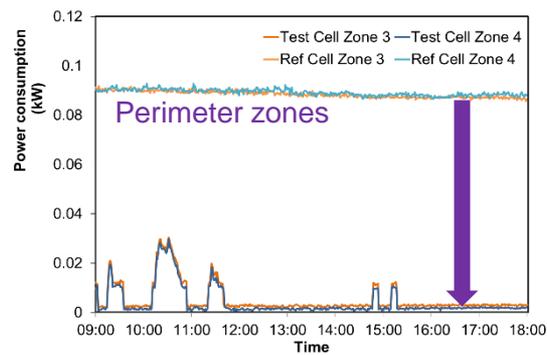
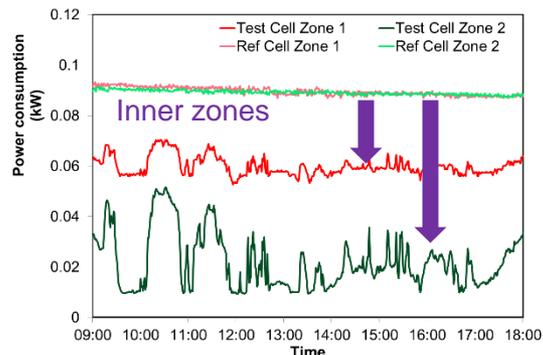
International Co-owners:



# Combined system – North

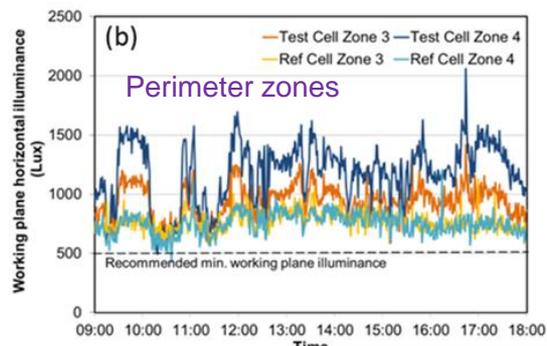
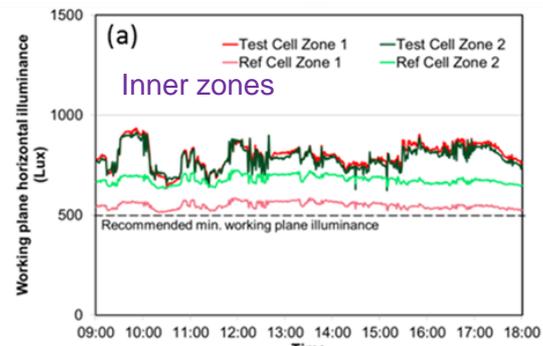
T5, no-dimming, close blinds vs LED, auto dimming, auto blinds

Lighting energy savings



Whole-cell lighting energy savings up to 74%

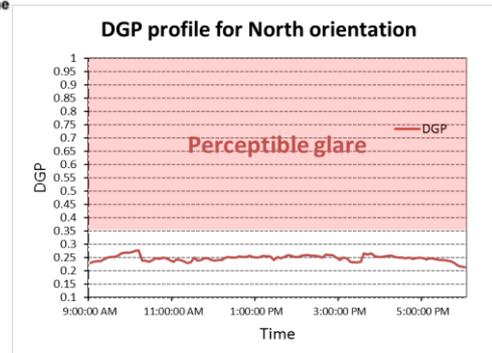
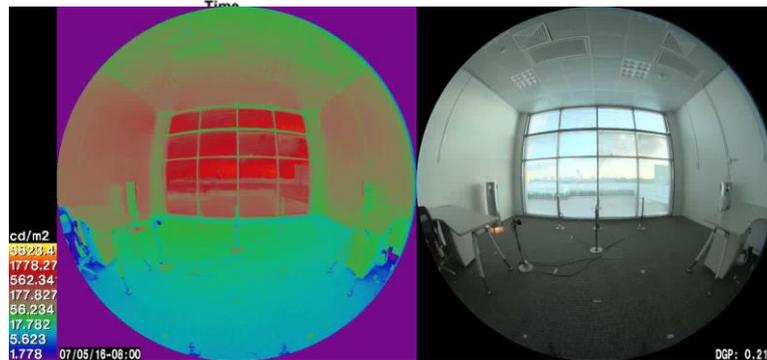
Working plane illumination



Working plane illumination level > 500 Lux\*

Perimeter zone do not exceed 3000 Lux\*\*

Glare control



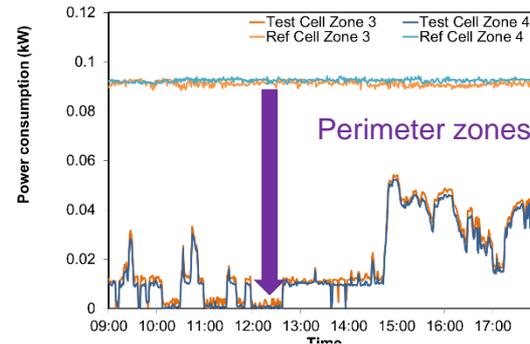
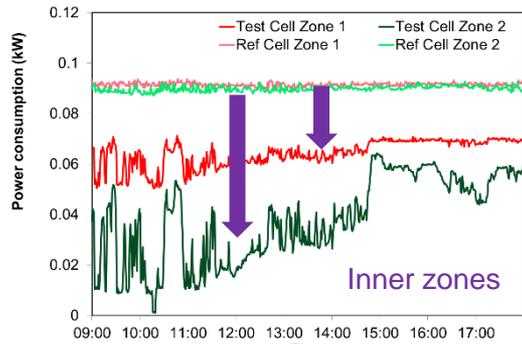
\*SS531: Part1: 2006 (2013)

\*\*Green Mark NRB2015 Technical Guide Requirements

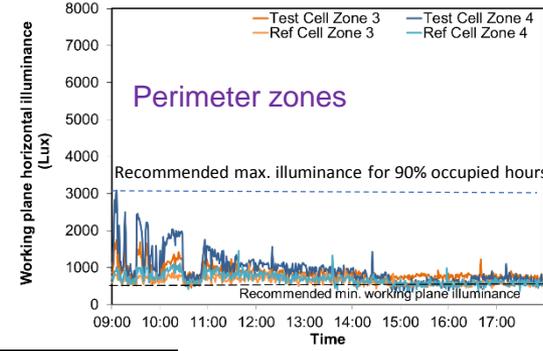
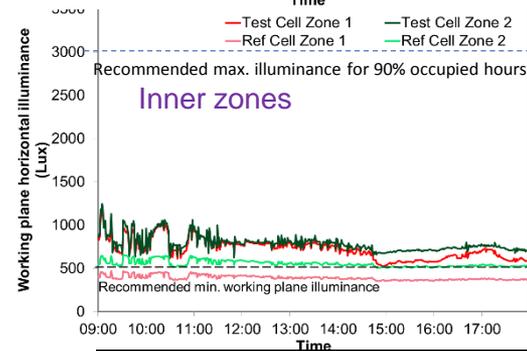
# Combined system – East

T5, no-dimming, close blinds vs LED, auto dimming, auto blinds

Lighting energy savings



Whole-cell lighting energy savings up to **63%**

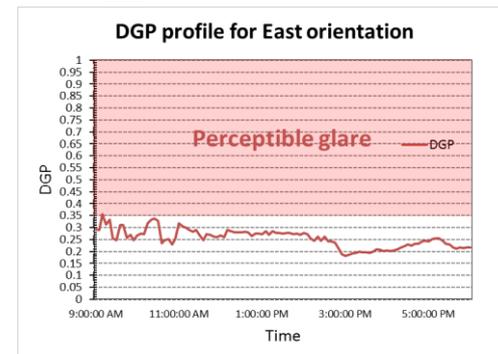
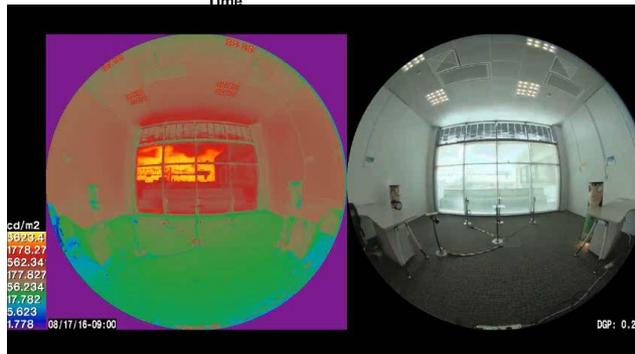


Working plane illumination level > **500 Lux\***

Perimeter zone do not exceed **3000 Lux\*\***

Working plane illumination

Glare control



\*SS531: Part1: 2006 (2013)

\*\*Green Mark NRB2015 Technical Guide Requirements



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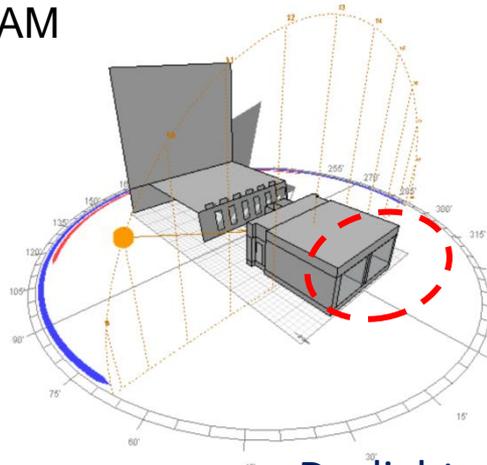
International Co-owners:



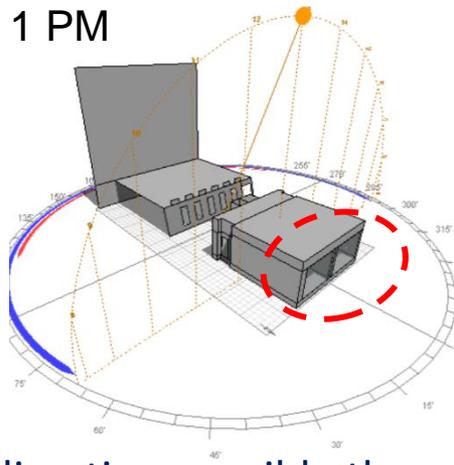
# Combined system – Impact of orientation

## North Orientation

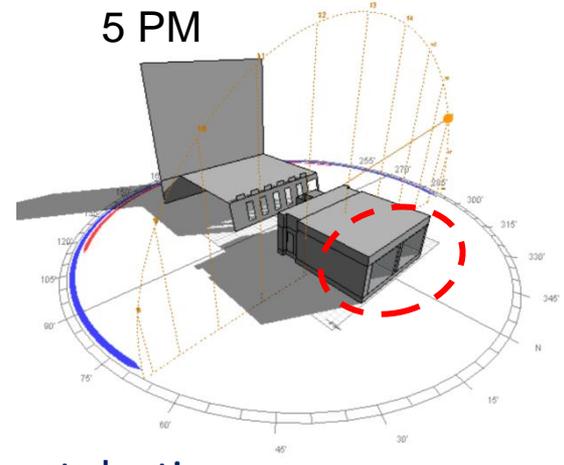
9 AM



1 PM



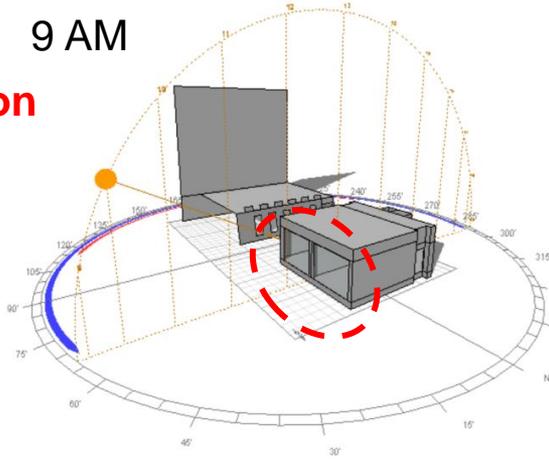
5 PM



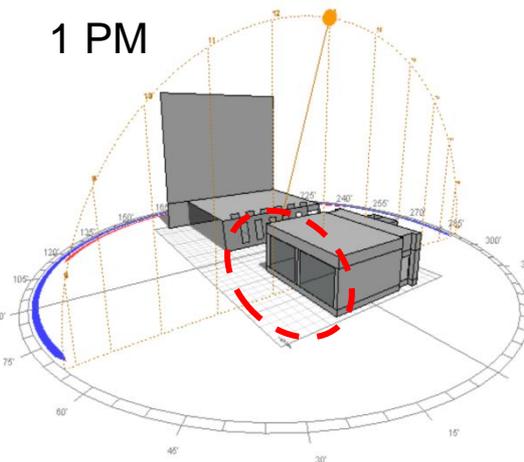
Daylight re-direction possible through out daytime

## East Orientation

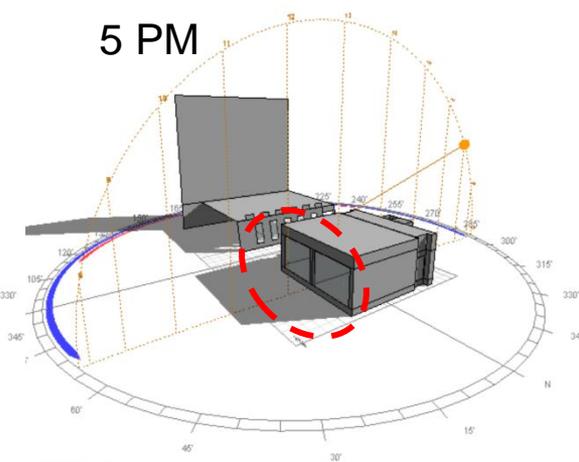
9 AM



1 PM



5 PM



Self-shading in the afternoon which reduces daylight re-direction potentials

# Combined system – Impact of orientation

Orientation	Lighting Energy Reference Cell <i>T5, No Auto-dimming, Closed blinds</i>	Lighting Energy Test Cell <i>LED, Auto-dimming, Automated blinds</i>	Lighting Energy Savings (kWh) <i>Contribution of LED, Auto-dimming and Auto-blinds</i>	Lighting Energy Savings (%) <i>Contribution of LED, Auto-dimming and Auto-blinds</i>
NORTH	9.79 kWh	2.51 kWh	7.28 kWh	74.35%
EAST	9.87 kWh	3.66 kWh	6.21 kWh	62.92%

- North orientation exhibits greater **lighting energy** savings than East orientation.
- Daylight re-direction is possible throughout the day in North orientation
- In East orientation, the glass façade is self shaded in the afternoon

# Conclusion



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Global Alliance  
for Buildings and  
Construction

# Conclusion

- **Auto-dimming** contributes to **47%** lighting energy savings
- **LED** contributes upto **42%** of lighting energy savings compared to **T5 fluorescent lamps**.
- **Combined system** achieves up to **74%** of lighting energy savings for **North orientation** and **63%** for **East orientation** while providing **good visual comfort** .

# Acknowledgement

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# Thank you



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