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Enabling Success

Testing on Laser/LED Safety and Solid State Lighting

Y. H. C. Kwan, Silas Hung, Vincent Chan†

Hong Kong Science & Technology Parks Corp.

† The Hong Kong Standard and Testing Centre

香港標準及檢定中心
Hong Kong Standards and Testing Centre

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HKSTP

Vision

- To play a leading role for Hong Kong to become a hub for high value-adding, skill-intensive manufacturing and service industry capacities.

Missions

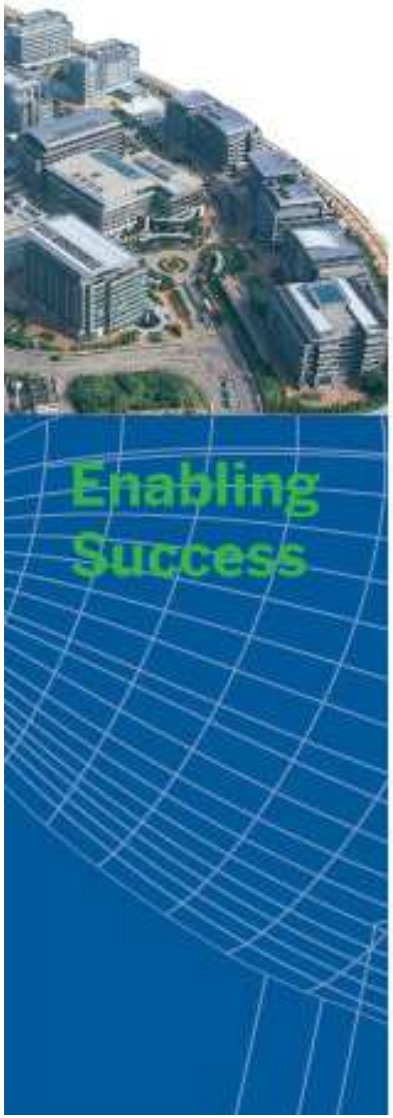
- To provide quality infrastructure and support facilities for innovation and technology development

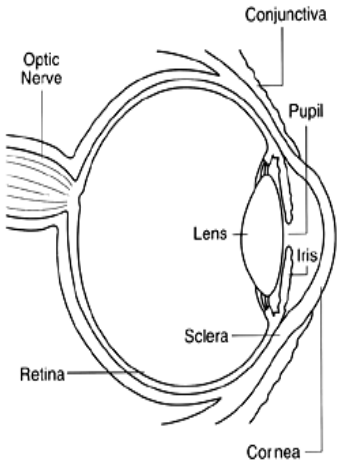
Focused Clusters

- Precision Engineering (including solid state lighting)
- Electronics
- Biotechnology
- IT & Telecommunications

Laser/LED Safety Measurement

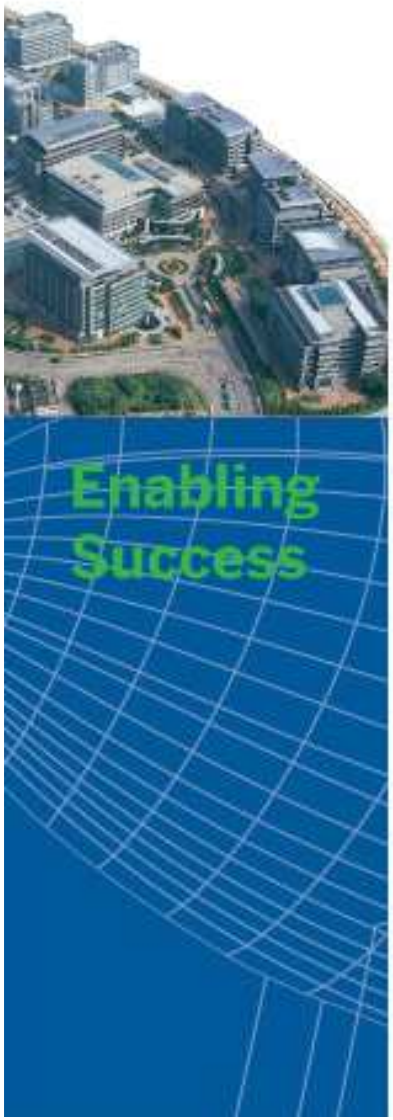
Eye response on different wavelengths





Wavelength (nm)	Response
<315nm (Short-Ultraviolet)	Absorbed in Cornea
315 to 400nm (Near-Ultraviolet)	Absorbed in Lens
400 to 700nm (Visible)	Focused on Retina
700 to 1400nm (Near-infrared)	Focused on Retina
>1400nm (Far-Infrared)	Absorbed in Cornea

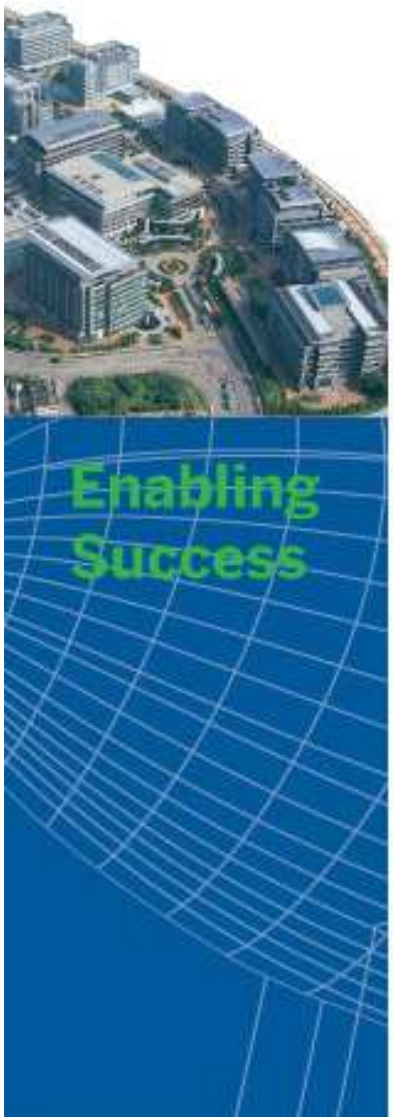
Safety Measurement on laser and LED is important



Laser/LED Safety Measurement

History on Laser Safety

- 1958: Invention of laser by Arthur Schawlow and Charles Townes at Bell Labs
- 1962: Invention of LED by Nick Holonyak at General Electric Company
- 1974: International Electrotechnical Commission (IEC) created Technical Committee 76, to address standards relating to laser safety. This committee developed the four-class system for lasers that is the global reference
- 1993: International standard on laser safety IEC60825-1 first edition is issued by IEC



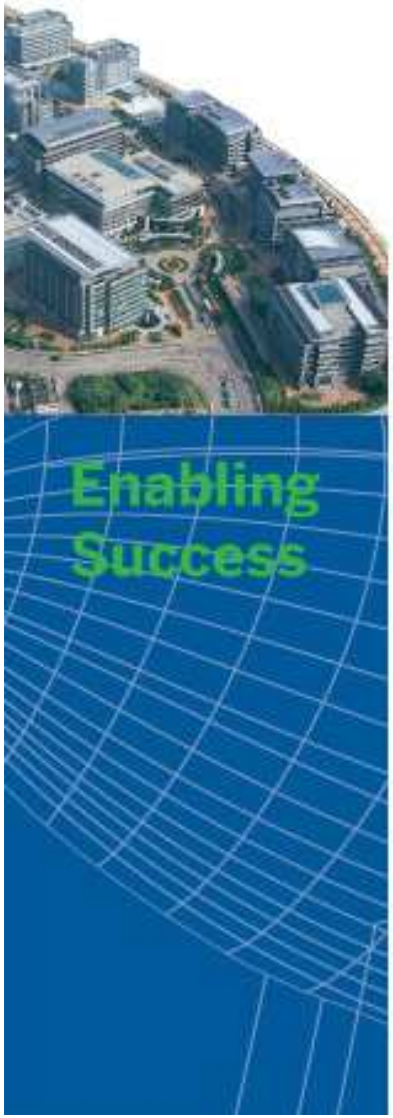
Laser/LED Safety Measurement

History on Laser Safety (cont'd)

- 1994: European Standard EN60825-1 is published for safety of laser products and identical to IEC60825-1
- 2001: Center for Devices and Radiological Health (CDRH) (21 CFR 1040.10 and 1040.11 in US) accepted IEC60825-1:2001
- 2007: IEC60825-1 is revised and LED is removed from this part of standards and suggested for IEC62471

IEC60825-1 is a widely used laser safety standard

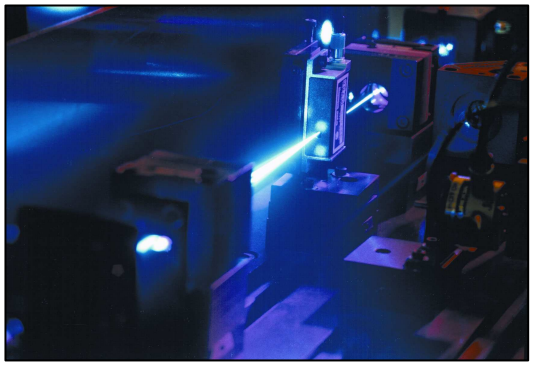
Laser/LED Safety Measurement

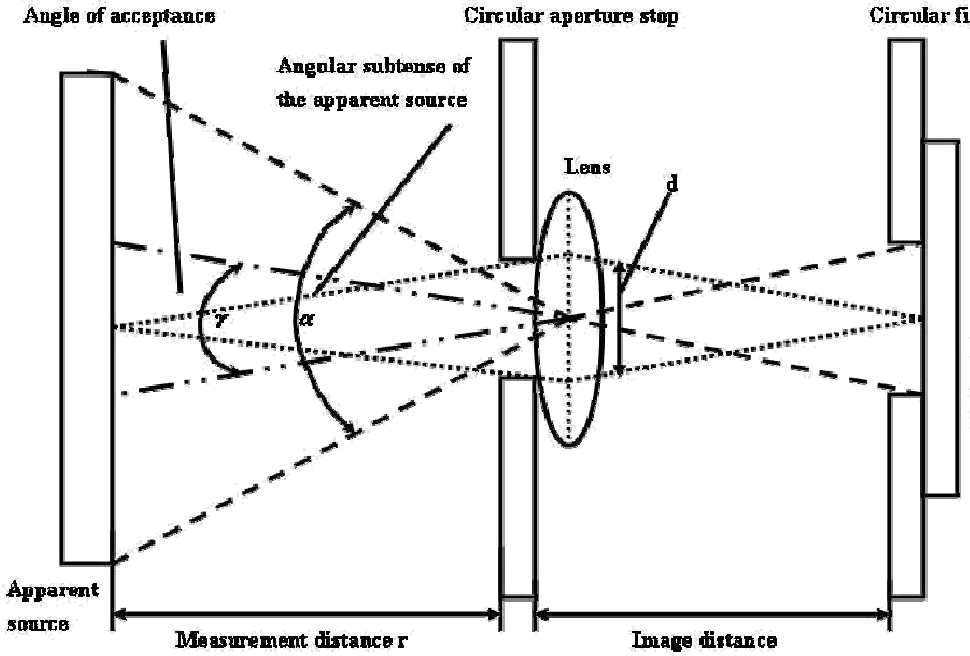


IEC60825-1 Standard

- **Measurement geometry**

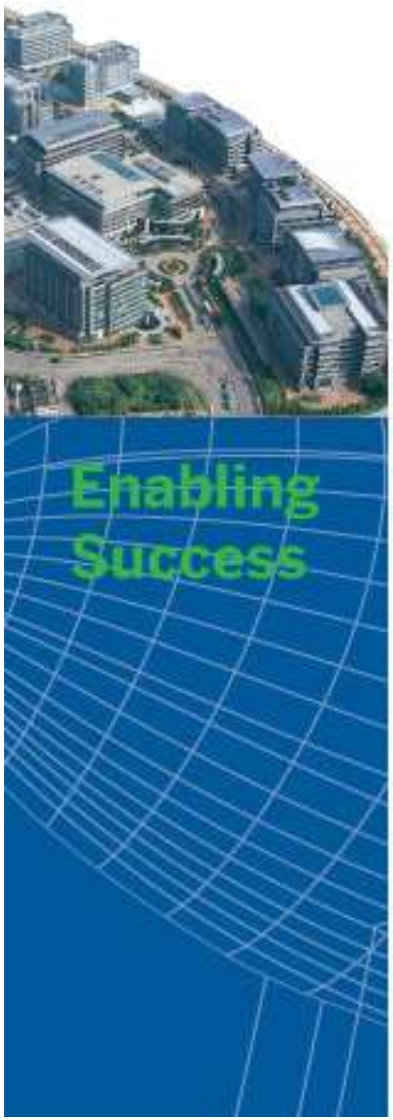
For LED, CW laser diode, etc





Variation parameters:

- **Aperture diameter d**
- **Measurement distance**
- **Current**
- **Voltage**



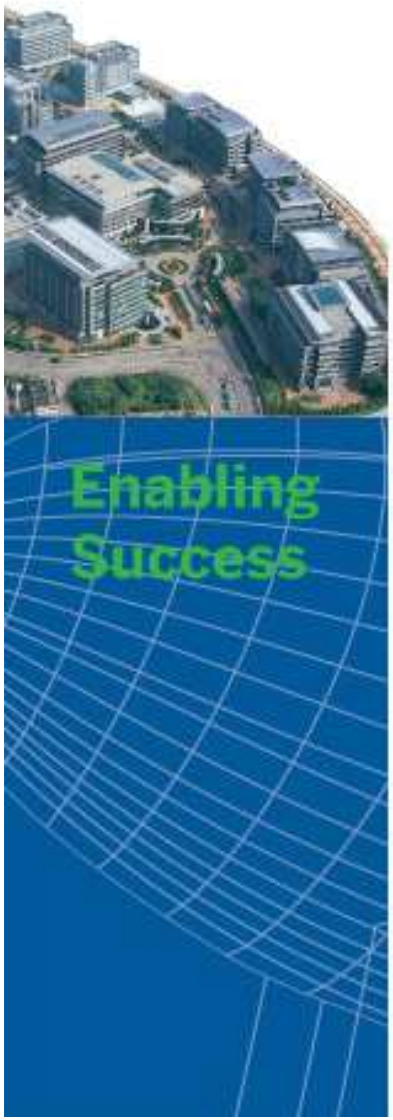
Laser/LED Safety Measurement

Two conditions in IEC60825-1

	Condition 1		Condition 2	
Wavelength (nm)	Aperture stop (mm)	Distance (mm)	Aperture stop (mm)	Distance (mm)
<302.5	NA	NA	7	14
302.5 to 400	25	2000	7	14
400 to 1400	50	2000	7	r

- r is calculated by the angular subtense of Laser/LED for photochemical limit and thermal limit

We consider the angular subtense > 100 mrad so that r = 100mm for both limits



Laser/LED Safety Measurement

Electrical input in LED with red color

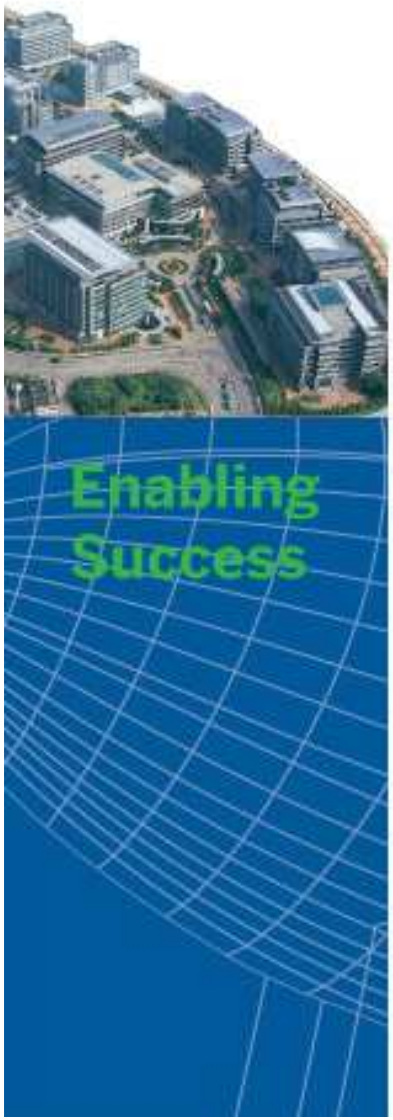
- constant current = 20mA and warm-up time is 1 min

Variation of Aperture Diameter at 7mm

Variation of Aperture Diameter	-1%	0	1%
Measured Optical power (W)	97.9 μW	100.1 μW	102.1 μW
Variation in Power Difference (Reference at 7mm)	–2.20%	0	2.00%

Power is measured at peak wavelength of 639nm

Reduced aperture diameter results in less power obtained in the detector



Laser/LED Safety Measurement

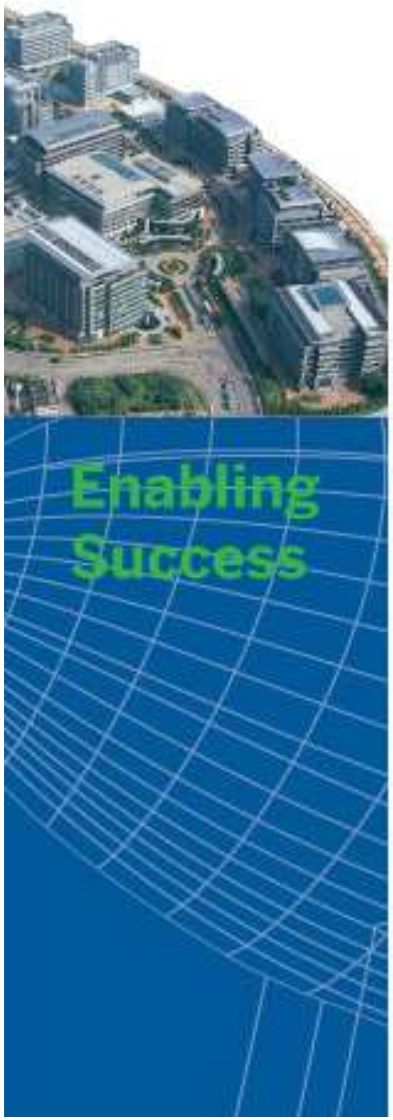
Electrical input in LED with red color

- constant current = 20mA and warm-up time is 1 min

Variation of Measurement Distance at 100mm

Variation of Measurement Distance	-1%	0	1%
Measured Optical power (W)	104.0 μW	103.0 μW	100.8 μW
Variation in Power Difference (Reference at 100mm)	0.97%	0	–2.14%

Shorter the measurement distance results in greater power



Laser/LED Safety Measurement

Electrical input in LED with red color

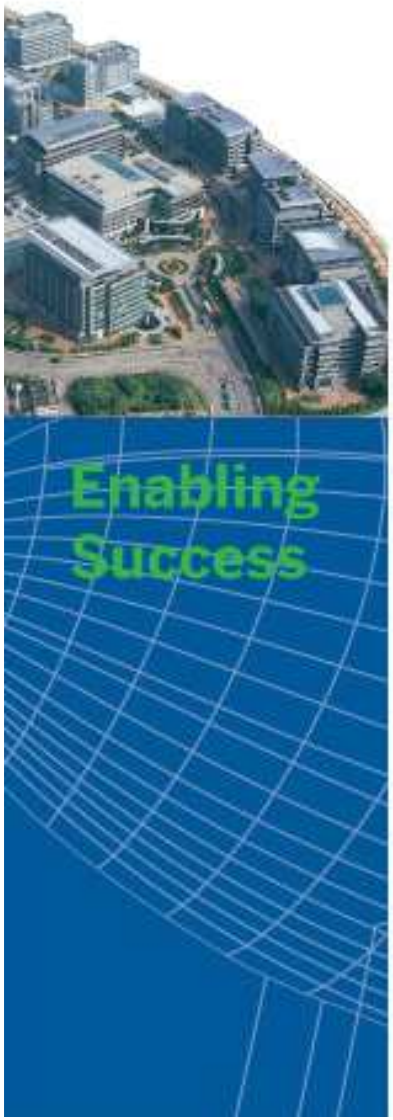
- warm-up time is 1 min

Variation of Constant Current at 20mA

Variation of Constant Current	-1%	0	1%
Measured Optical power (W)	101.9 μW	103.0 μW	104.0 μW
Variation in Power Difference (Reference at 20mA)	–1.07%	0	0.97%

Increase the current has larger power output in LED

Laser/LED Safety Measurement



Electrical input in LED with red color

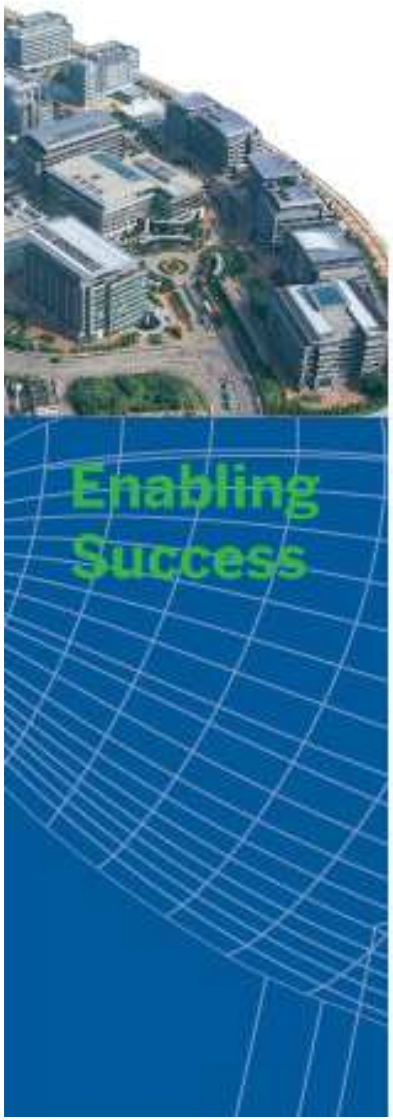
- warm-up time is 1 min

Variation of constant voltage at 2.1900V

Variation of Constant Voltage	-1%	0	1%
Measured Optical power (W)	95.7 μW	105.7 μW	116.2 μW
Variation in Power Difference (Reference at 2.1900V)	–9.46%	0	9.93%
Variation in Current Difference (Reference at 2.1900V)	–9.22%	0	9.71%

Use constant current rather than constant voltage to avoid any deviation in voltage during measurement

Laser/LED Safety Measurement



IEC60825-1
Standard

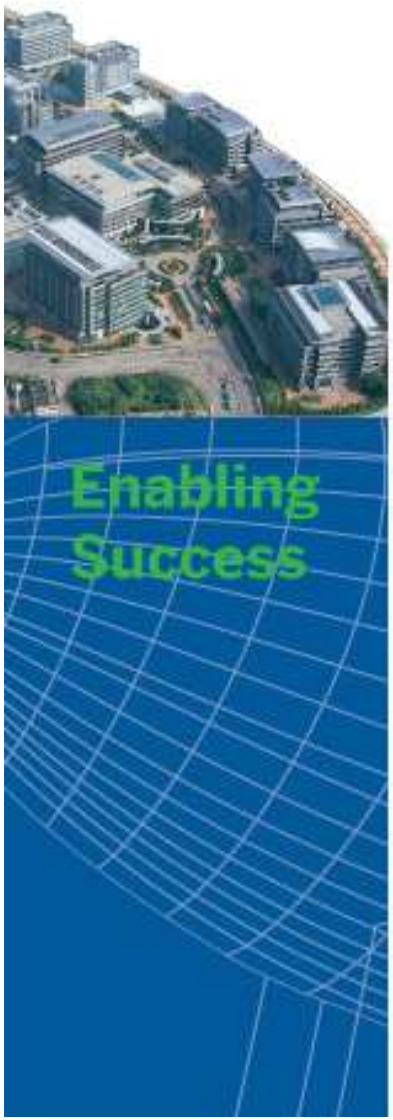
Classification is based on

- **Wavelength range**
- **Angular subtense**
- **Exposure time**
- **Emitted power**

Classified into 4 classes by the Accessible Emission Limit (AEL) of each class

Classes	Hazards	AEL[#]
Class I & 1M	Safe to skin and eye	<Few tens of µW
Class 2 & 2M	Safe to skin	1mW
Class 3R	Harmful to eye	5mW
Class 3B	Harmful to eye	0.5W
Class 4	Danger to eye	>0.5W

[#] Based on CW laser in visible wavelength range

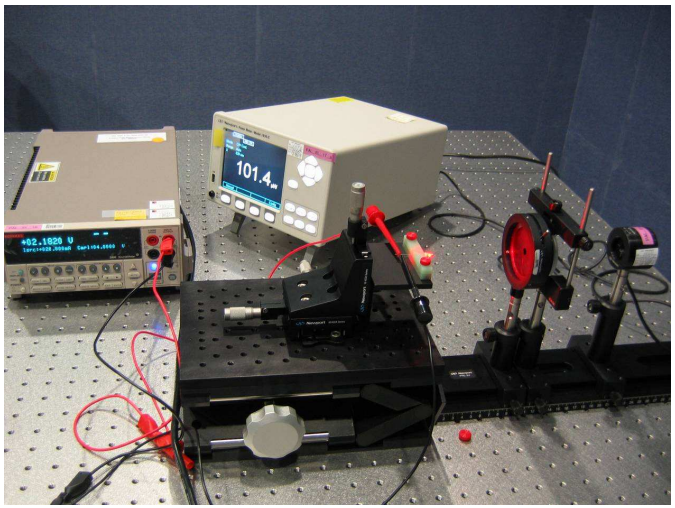


Laser/LED Safety Measurement

Measurement Setup of Laser/LED Safety

- Facilities in HKSTP
- Develop with HK Standard and Testing Centre (STC)

MOU Signing Ceremony



Measurement Setup

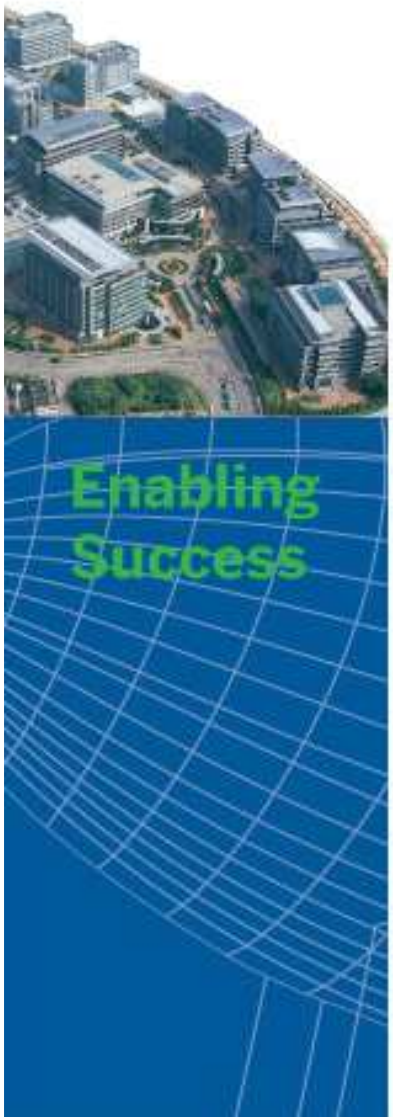
Testing of LEDs

Measurement of luminous flux Φ_V

- Facilities in HKSTP
  - Sphere with 75mm diameter
    for LEDs
  - Sphere with 500mm diameter
    for halogen lamps, small lamps, MR16, LED clusters, LEDs

CIE127:2007

Source: Instrument Systems, Inc



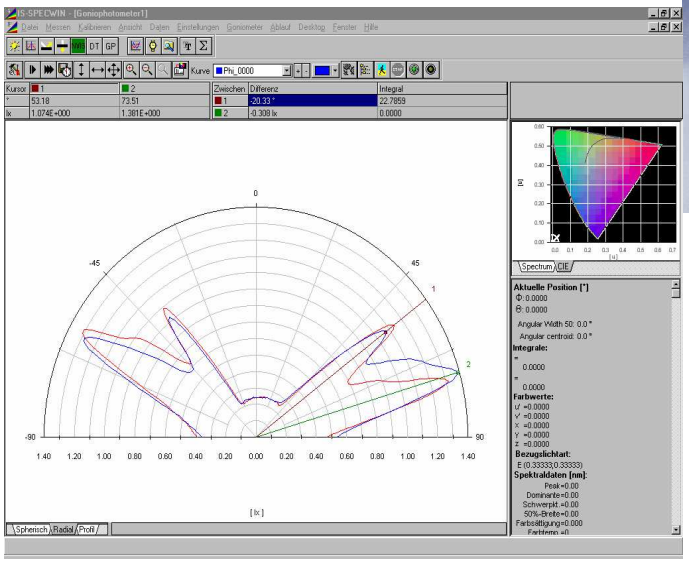
Testing of LEDs

Measurement of luminous flux Φ_v

- Facilities in HKSTP
  - Goniophotometer

    for LEDs
    - obtain beam profile

Source: Instrument Systems, Inc



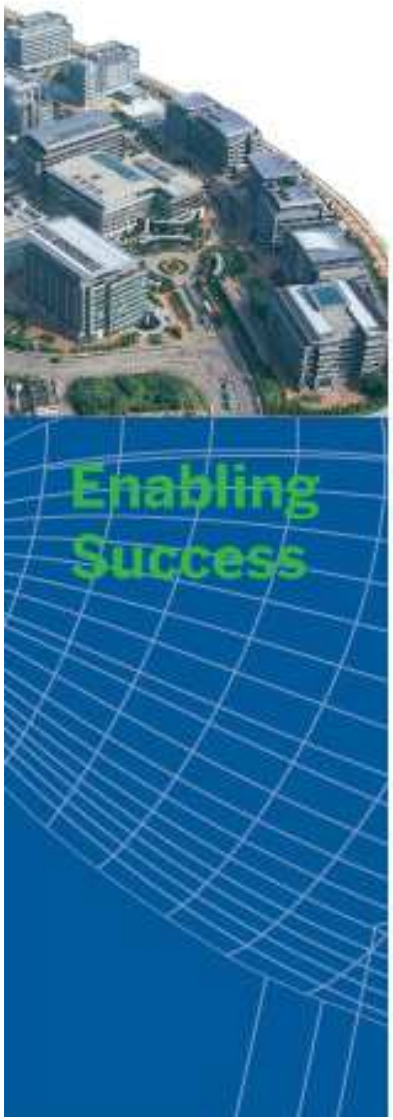
Testing of LEDs

Measurement of luminous intensity I_v

- Facilities in HKSTP
  - Optical probe with test socket
    for 3mm/5mm packaged LEDs
  - Goniophotometer
    for CIE127A

CIE127B

Source: Instrument Systems, Inc



Testing of Displays

Measurement of luminance L_v

- Facilities in HKSTP
  - Display tester DTS500

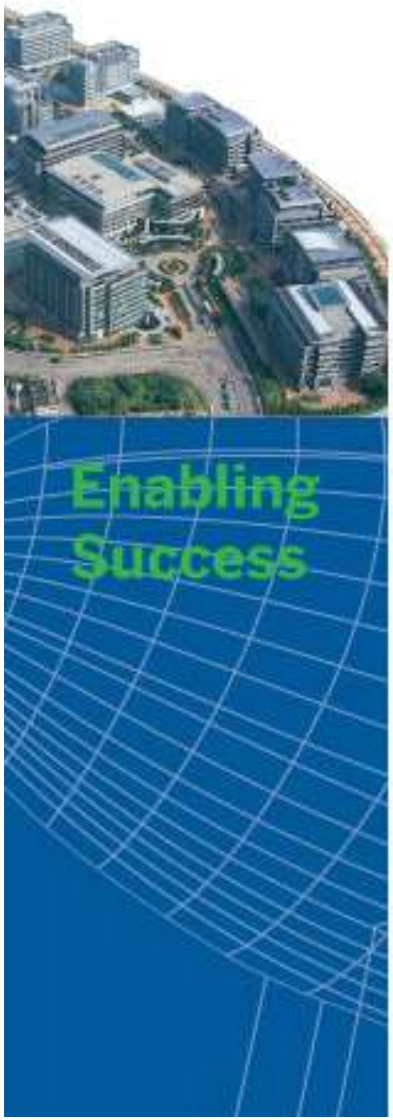
    for laptop screen,

    panel in automobile,

    LCD backlighting

Source: Instrument Systems, Inc

Testing of Displays



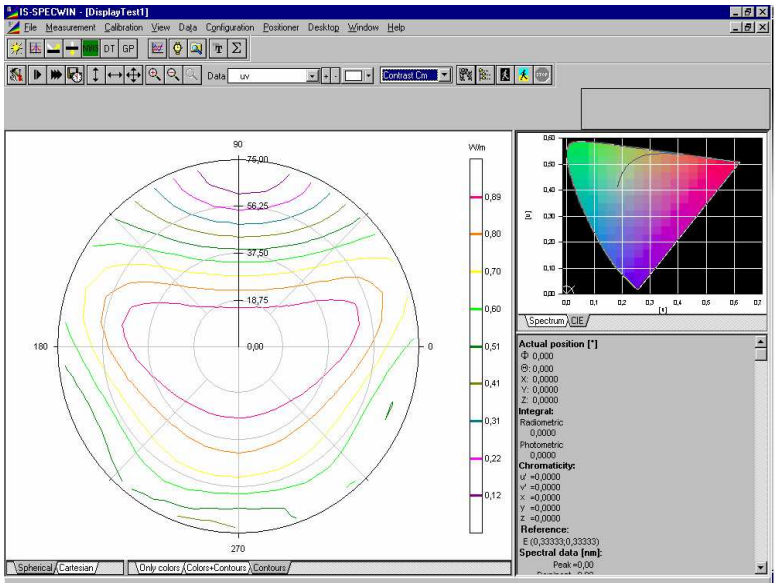
Measurement of viewing cone

- Facilities in HKSTP
  - Display tester DTS500

    contour plot,

    contrast ratio,

    uniformity, etc



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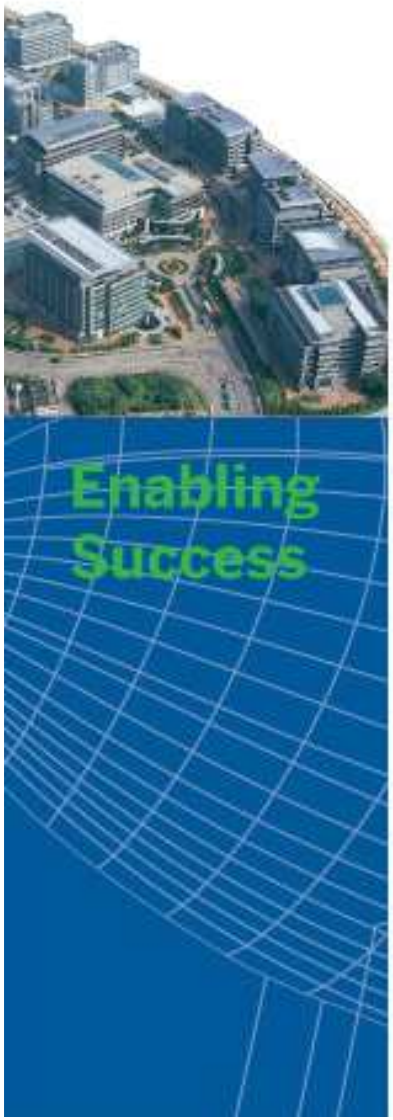

Summary

Measurement of Laser/LED Safety

- Study the variation of the measurement parameters
- Found that constant voltage results in the largest variation of optical power
- Should use constant current instead of constant voltage in measurement

Measurement of Solid State Lighting Testing

- Point out the equipments for luminous flux, luminous intensity, and beam profile for LEDs;
- Luminance and viewing angle measurement for displays

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Thank You

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http://www.pal.hkstp.org
canny.kwan@hkstp.org