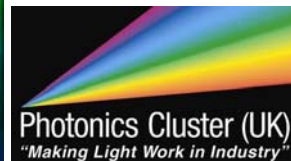


LED Technology: lessons from Japan and the USA

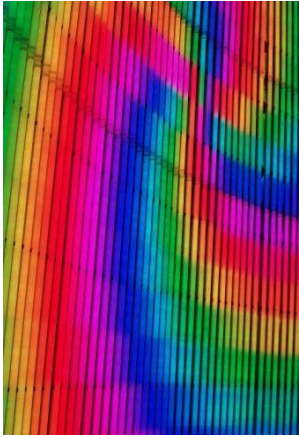
# LED TEST AND MEASUREMENT STANDARDS

W N Wang  
NCTU and University of  
Bath



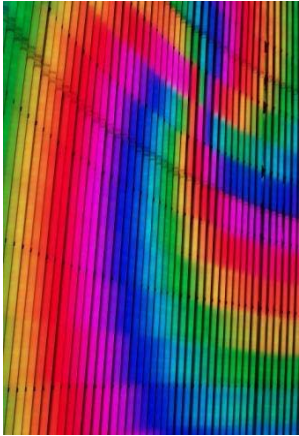
dti

Global Watch is a DTI service managed by Pera



## LED technology: lessons from Japan and the USA

This presentation material is based on the contribution of Mike Bean of Carclo Technical Plastics in the UK DTI mission report

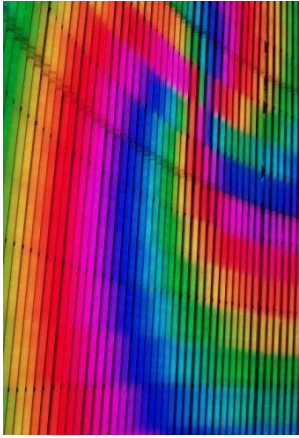


LED technology: lessons from Japan and the USA

# Market needs, standards, and infrastructure

*How can we adopt SSL technology in practical lighting systems ?*

- Accurate and reliable performance figures
- Consistent format for easy comparison
- A standard definition for LED lifetime
- Better metrics for LED colour characterisation (consistent colour 'binning' method)
- A comprehensive, exclusive standard for LED eye safety - safe limits and best practice guides



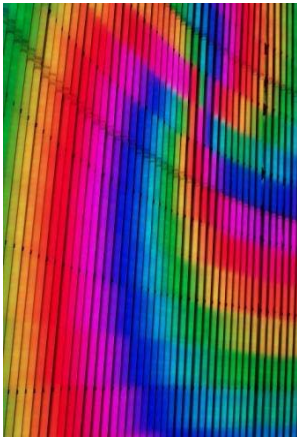
LED technology: lessons from Japan and the USA

# DOE 2006 SSL Program Planning Workshop (Feb '06)



*Who is co-ordinating the effort to look  
at these issues in the US ?*

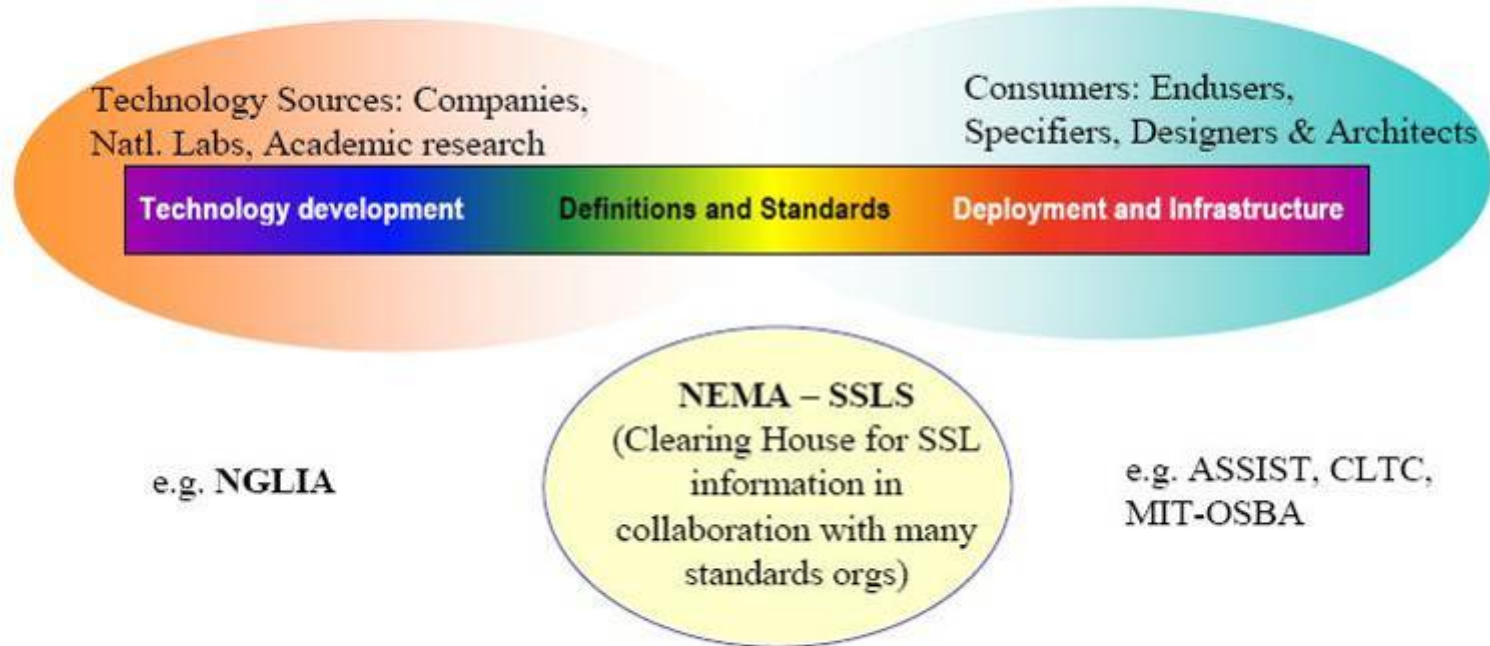
- US DOE (Department Of Energy)
- NEMA-SSL (National Electronic Manufacturers Association - SSL Section).
- NGLIA (Next Generation Lighting Industries Alliance)
- ASSIST (Alliance for Solid-State Illumination Systems & Technologies)
- NIST, IEC, ANSI...etc (Standards organisation )



## LED technology: lessons from Japan and the USA

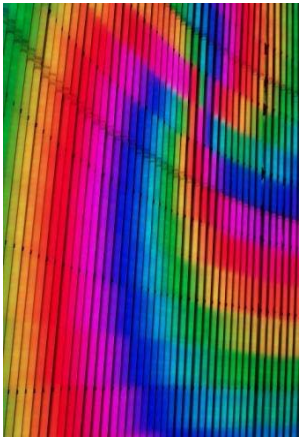


# The spectrum of cooperation in the SSL Industry



DOE started with technology development and extending to commercialization support

# Vision & Technical Activities



- Strategic Task Force created to look at NEMA-SSL Roadmap
  - Establish strategic vision for the industry
  - “... tasked with *integrating* solid state light sources with existing *lighting practices* and the creation of new practices to fully exploit the technologies *potential*”
  - Avoid duplication of effort
  - Develop a roadmap
- Technical activities
  - Developing *working guidelines* for adoption by the Standards organisations in the long term
  - NEMA-SSL – clearing house for reliable, well accepted information, e.g. “lifetime,” ratings, lumens, LPW etc...
  - Established glossary of terms for a common language
  - Matrix of standards



# Activities continued...

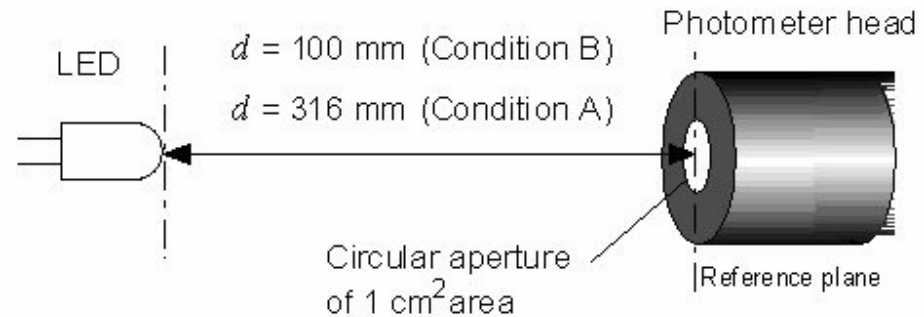
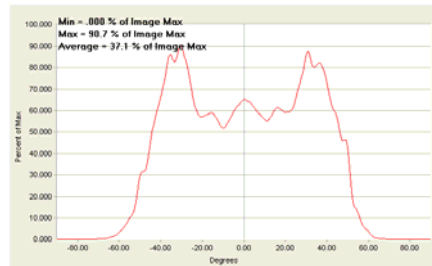
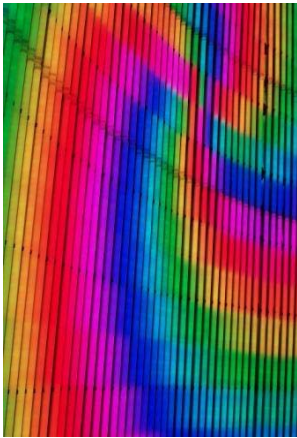
- ANSI Working Groups for Solid-state Lighting.
  - Working Group C78-09 for light sources
  - Working Group C82-04 for (electrical) control devices
  - Next meeting: May'06 Rosslyn, VA
- IESNA Performance Standards, Section's Technical Committee has initiated *round-robin* testing of LED's.



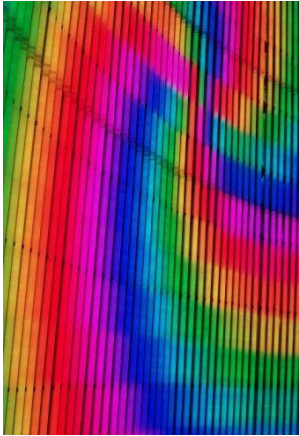
- UL Safety Standards.
  - Currently, LED safety requirements applied from more than *twelve different UL safety standards*
  - UL plans to deliver a draft consolidated document by the end of February 2006 for LED's



# Intensity Measurement



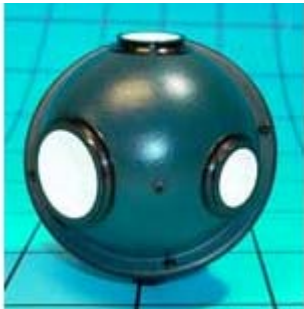
- Most LEDs are not point sources...
- In 1997, CIE 127 introduced standardised geometries to allow comparison using Average LED Intensity
- Now, CIE Technical Committee (TC) 2-46 preparing a CIE/ISO update to revise CIE 127.

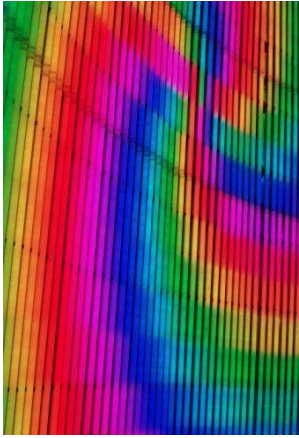


# LED Flux Measurement

## Why measure LED output ?

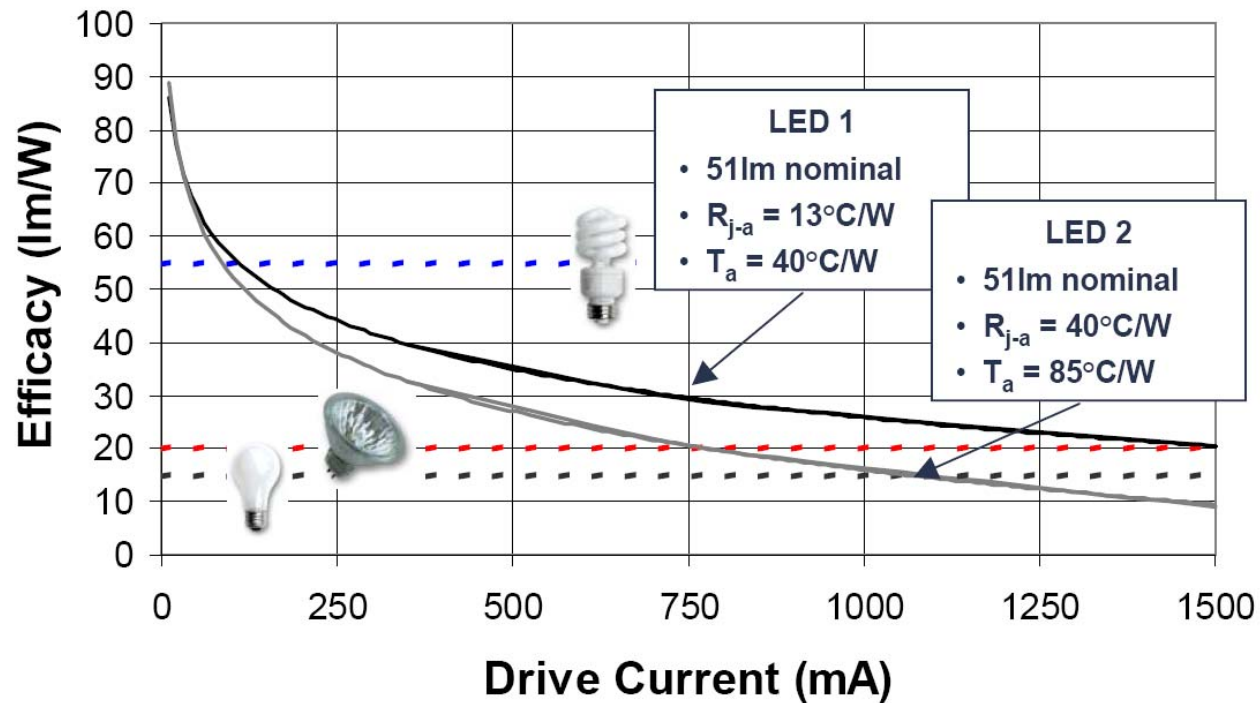
- Errors when using Integrating Spheres
  - Set-up geometry ( $4\pi$  or  $2\pi$ )
  - Drive current drift (T °C, Forward voltage)
  - Deviation of detector spectral response
  - Package not at thermal equilibrium
  - LED clusters
- CIE TC 2-45, TC 2-50 and IESNA Project 78 will address many of these issues.





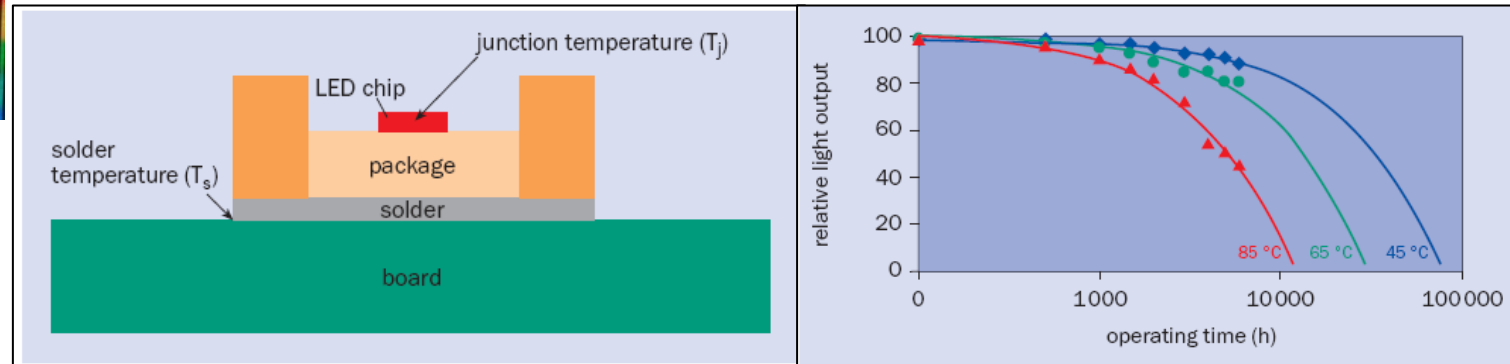
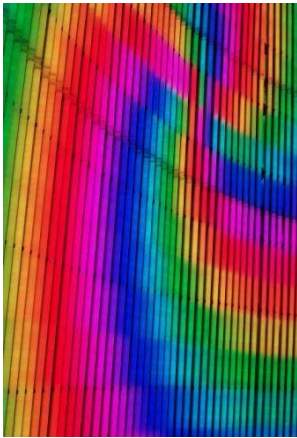
# Efficacy (lm/W) measurements

- Optical power out (lm) / Electrical power in (W)
- Not constant over drive current range
- Influenced by package thermal management



Graph Courtesy of Cree Inc.

# LED Lifetime (or Lumens maintenance)

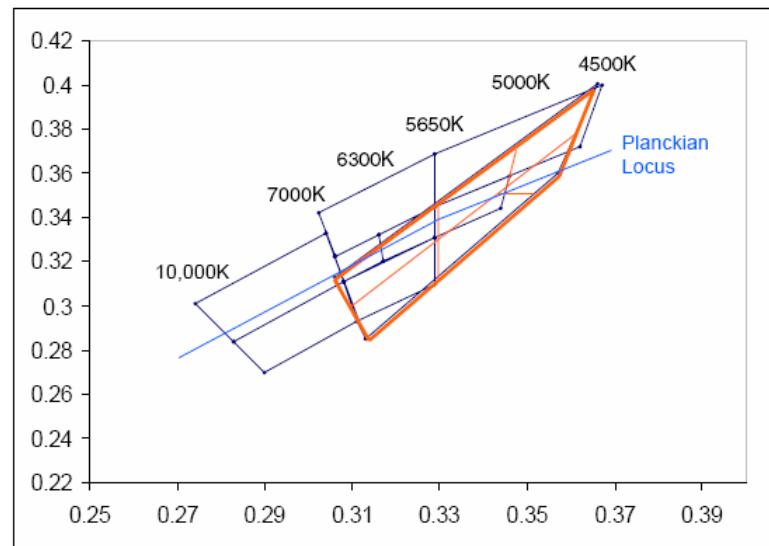


- ASSIST published (Feb'05) recommendations defining and measuring LED lifetime
  - General - 70 % lumen maintenance
  - Decorative - 50 % lumen maintenance
- Measured at three package temperatures ( $T_s$ )
  - High power (>100mA) - 45 °C, 65 °C and 85 °C
  - Low-power (< 100mA) - 35 °C, 45 °C and 55 °C

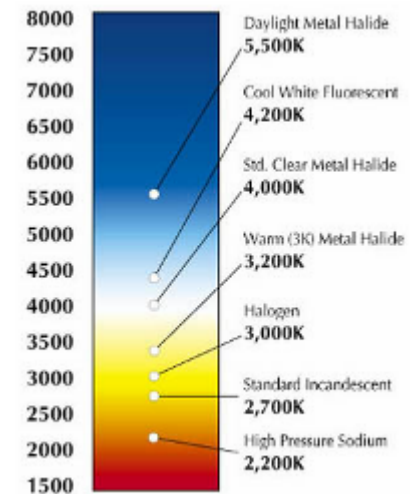
# Binning

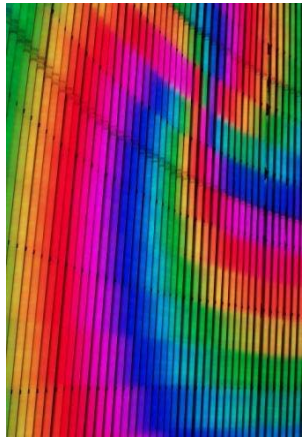
- Same old problem: Variation of Colour in a LED batch
- Solutions: Reduce manufacturing variability or Group LED's according to their black-body colour temperature (CT)
- Lumiled introducing new binning structure Q2 2006
  - Larger number of smaller bins
  - Committed to reducing CT variation to +/-50K

Chart showing variation in bin structures for different LED manufactures, courtesy LumiLeds.



Black-body temperatures

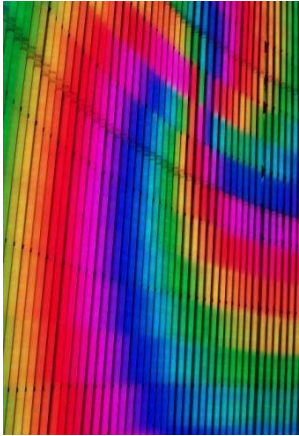




# Colour Render Index

- Currently investigated by CIE's (Vision and Color) TC 1-62 "Colour Rendering of White LED Light Sources".
  - Problem prominent with narrow-band sources, RGB white LEDs or multi-chip white LEDs
  - Sixth International Lighting Research Symposium on developing a colour characterisation metric held by EPRI February 6-8, 2006, in Orlando, FL.
- Manufacturers developing products along two paths for warm-white LED's:
  - High CRI (90+) at 20+ lumens (@350mA) for colour-rendering critical applications, like halogen replacements
  - Average CRI (70+) at 30+ lumens (@350mA) for luminance and less critical applications (eg landscape, cove, wall-wash, etc...)



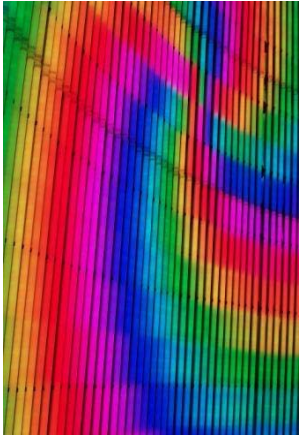


# Photobiological Safety Standards

- HB LED's in traffic lights, torches and car headlamps can be shone directly into eyes
- Standards used to confirm Safety Classification
- Related to spot size formed on back of retina
- LEDs have been treated both as lasers in IEC 60825 series and as lamps CIE S009/E:2002 "Photobiological safety of lamps and lamps systems"



NeoBulb™  
460 lm @  
470mA



# Summary

- Government-Industry focus groups (eg NEMA-SSL) working together to agree definitions and standards.
- UL plans to deliver a draft consolidated document by the end of February 2006 for LED's
- ASSIST published (Feb'05) recommendations defining and measuring LED lifetime
- The reference to LED's will be taken out of the 60825-1
- Joint IEC/CIE Standard DS 009/E-2002 'Photobiological Safety of Lamps and Lamp Systems' currently being updated to cover LED's