

Connecting Metrology, Standards, and Conformity Assessment at NIST and Beyond
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Solid-State Energy Efficient Lighting – LEDs

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Photometric Measurement Services

- National standards for light measurements
 - Luminous Intensity – candela
 - Total Luminous Flux – lumen
 - Correlated color temperature – Kelvin
 - LED calibration - candela, color
 - Flashing lights – lx·s
 - Sphere source luminance – cd/m²
- Calibration services for detectors and instruments
 - Illuminance responsivity – A/lx
 - Luminance responsivity – A/cd/m²



SSL products are rapidly introduced into the market



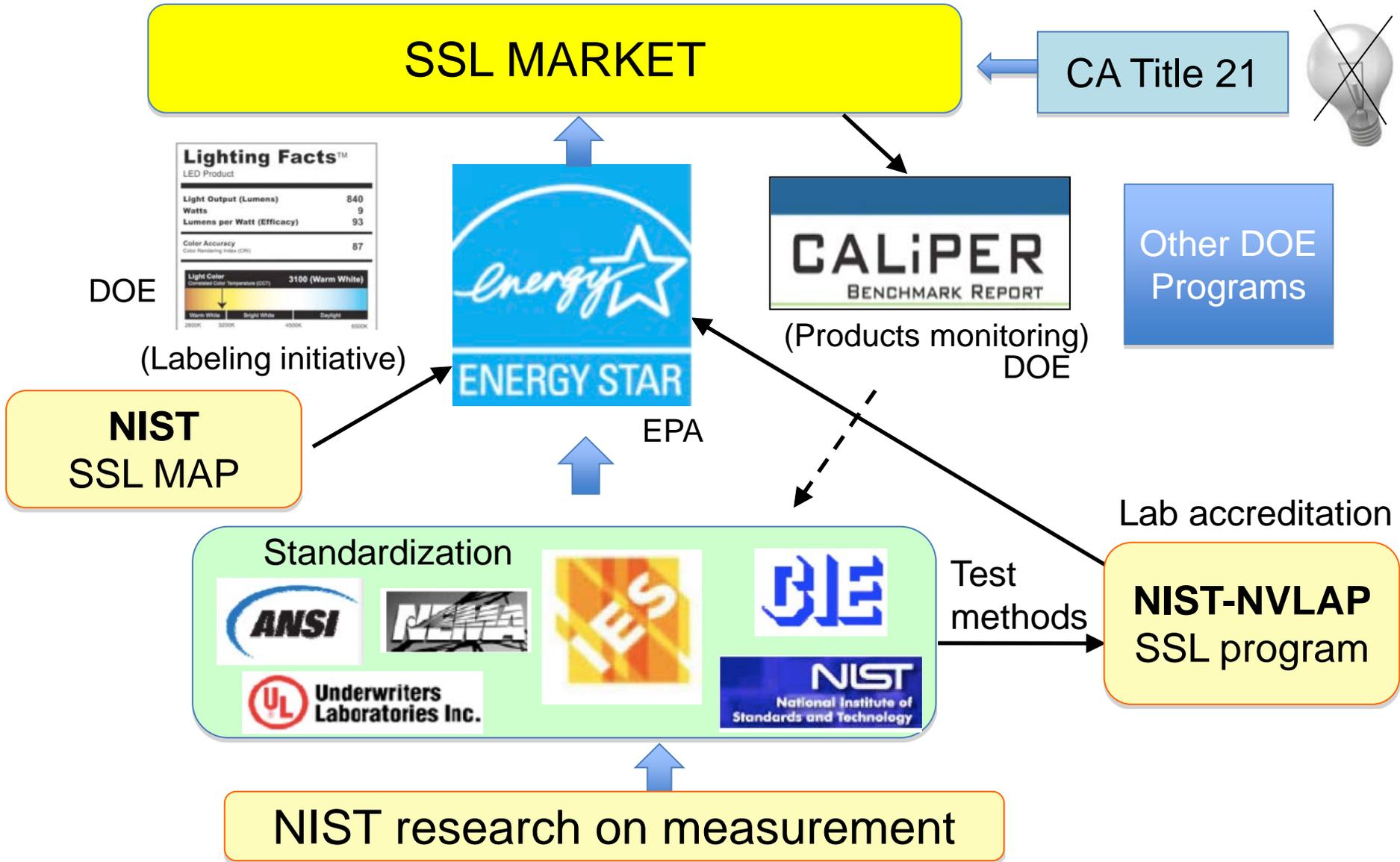
Problems

- Some very low quality products in the market (dim, short life, bad color).
- Inaccurate performance claims
- Insufficient information on product labels

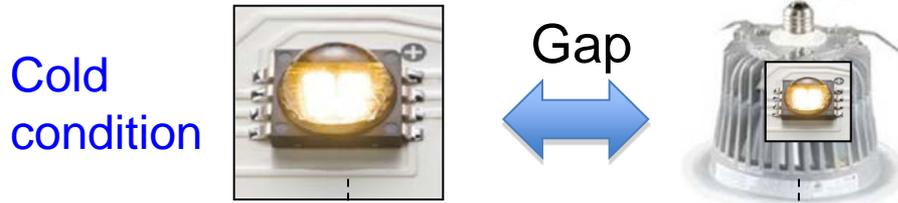


**Big concerns
worldwide**

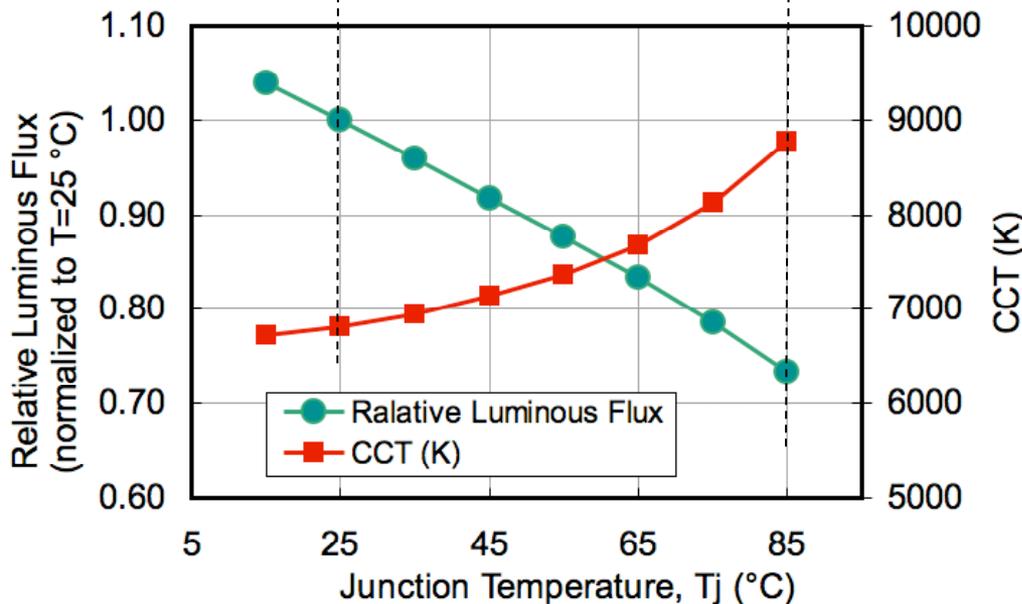
Regulatory and standardization efforts in USA



NIST Metrology – Documentary Standards



LEDs are very hot when operating in lighting products (often $T_j > 100^\circ\text{C}$)



LED performance at hot conditions needs to be known.

Measurement with a short pulse (LED manufacturers)



Measurement at steady DC operation (lighting industry)

LED manufactures measure and rate LEDs at cold condition ($T_j=25^\circ\text{C}$).



NIST Research on Measurement of high-power LEDs

Heat sink temperature
Pin temperature
Case temperature
Board temperature

Not always reproducible,
available, nor comparable.

Junction temperature (T_j) is the physical quantity of an LED that reproduces exactly the LED operating condition universally, anywhere.

NIST developed a practical method for measuring LEDs at the full rated DC current at any given junction temperature (using temperature-controlled heat sink).

Standards based on this method are being developed in IESNA and CIE.

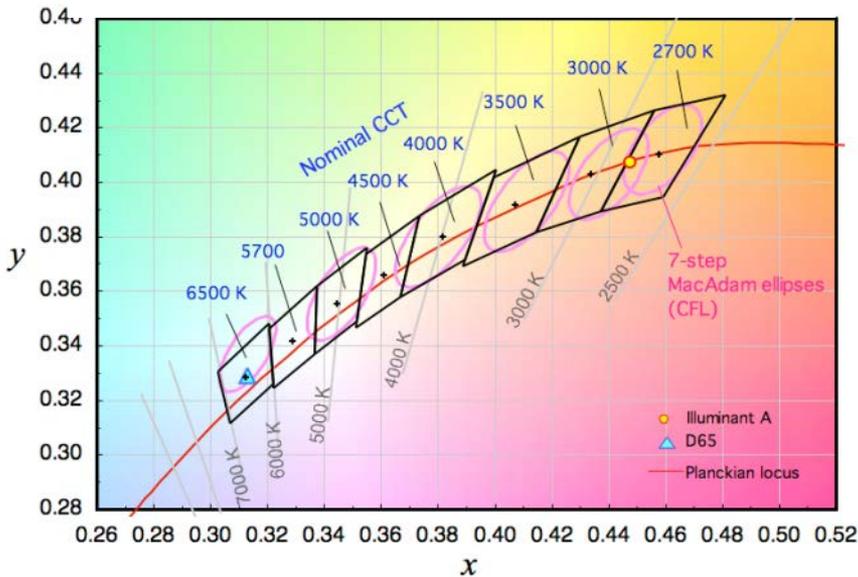


Measurement standard aims to satisfy both LED and lighting manufacturers



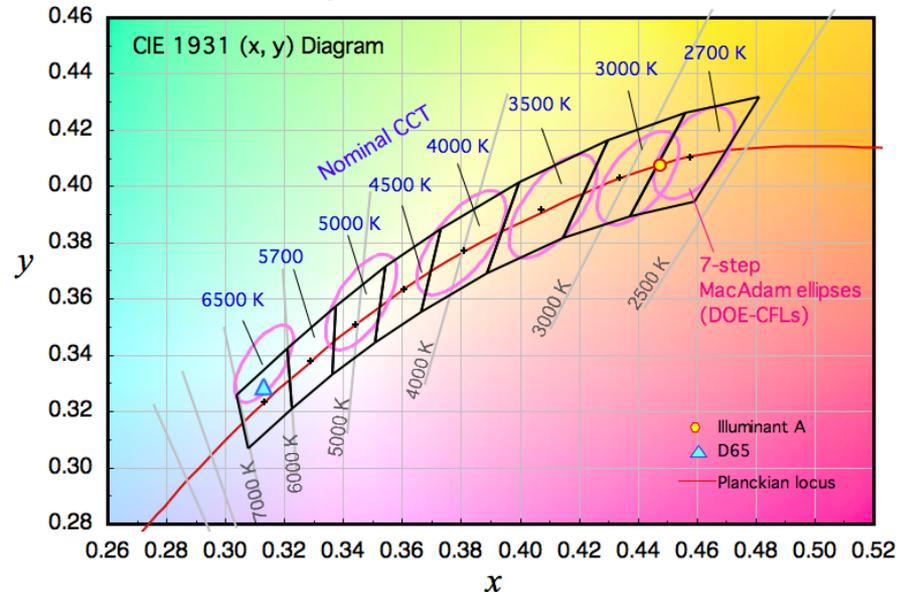
Revision of ANSI C78.377 (in progress)

Current version



- Published in 2008.
- Major contribution by NIST.
- Used by Energy Star and worldwide.

Proposal for revision



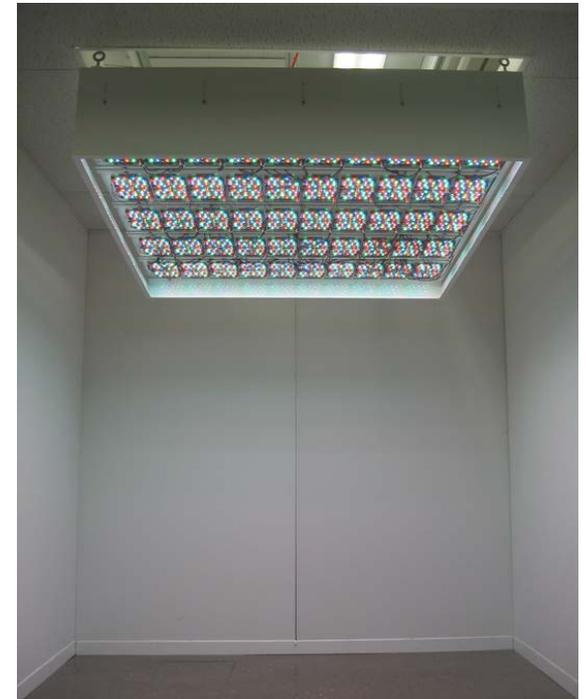
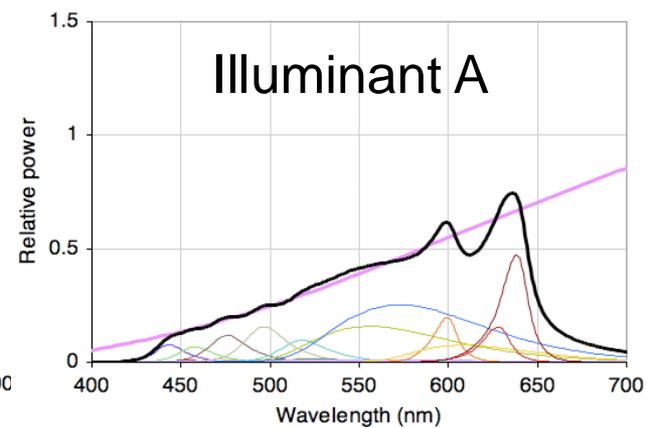
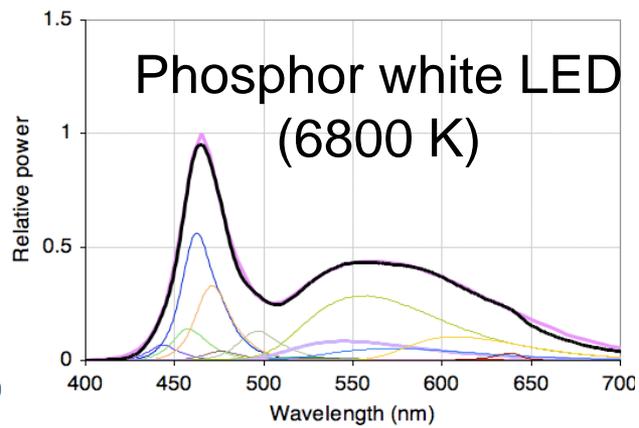
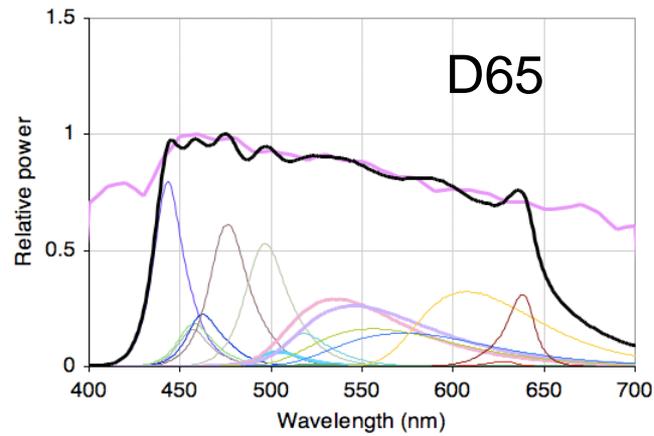
- All center points to be moved onto the Planckian locus.
- This proposal is pending.
- **NIST is funded by DOE to conduct vision experiments .**

Spectrally Tunable Lighting Facility

Installed Feb. 2009



Research Approach



Laboratory Accreditation Program for SSL Testing

NIST HANDBOOK 150-1A
2009 Edition



**National
Voluntary
Laboratory
Accreditation
Program**

**ENERGY EFFICIENT
LIGHTING PRODUCTS –
SOLID STATE LIGHTING**

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- SSL program was required for Energy Star and Lighting Facts labeling program.
- Established in 2009 (under support by DOE)
- **45** laboratories have applied to NVLAP
 - 26 United States
 - 14 China
 - 3 Taiwan
 - 1 Canada
 - 1 Italy
- DOE sponsored Laboratory Training
 - February 16-17, 2010
 - 34 laboratory representatives
- Assessor Training – February 7, 2008

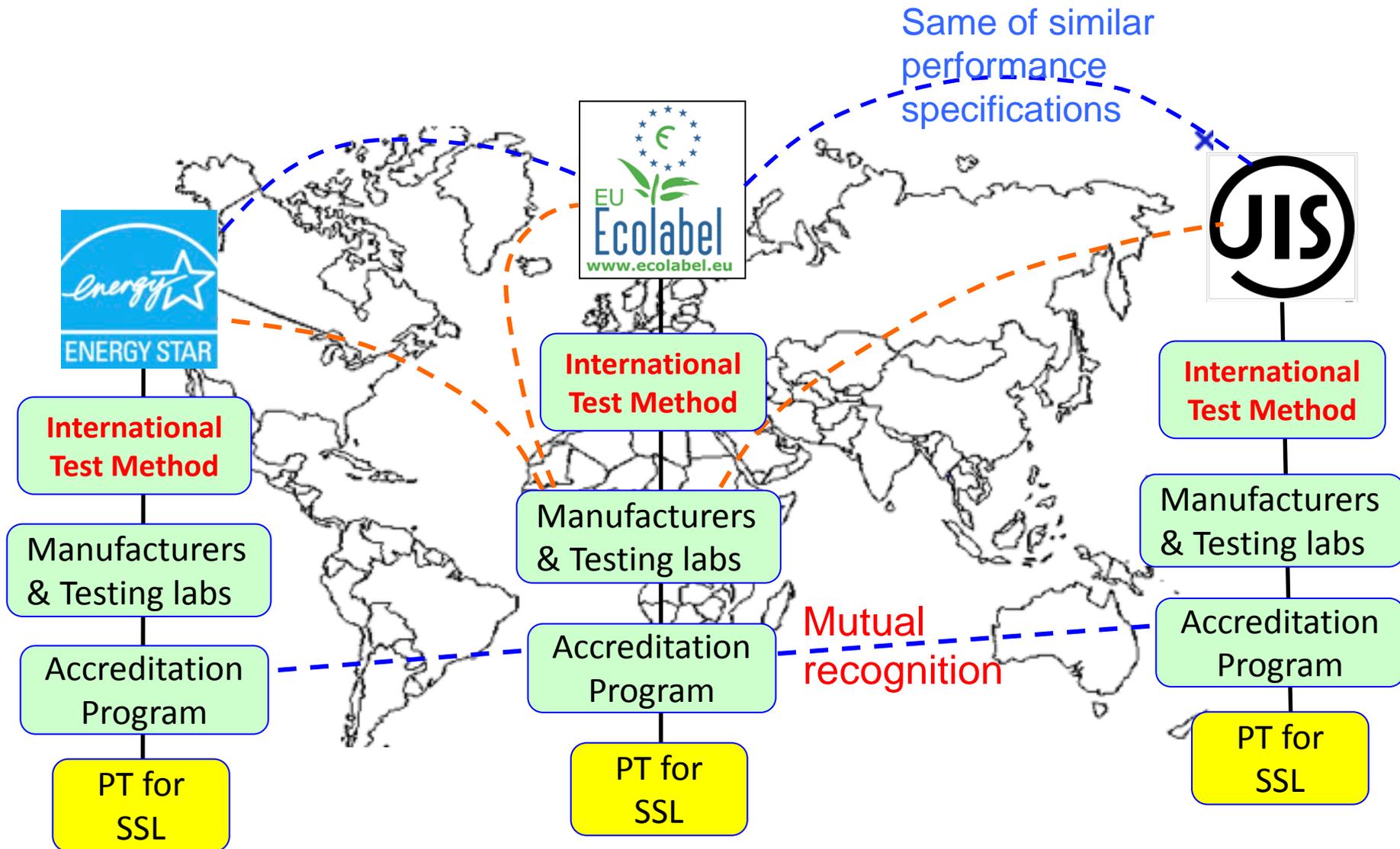
SSL Measurement Assurance Program

- Six different products – PT-January 2010, MAP-March 2011



- 45 laboratories associated with NVLAP
- 35 laboratories associated with other accrediting bodies
 - 9 United States
 - 5 Taiwan
 - 1 Singapore
 - 1 Germany
 - 14 China
 - 2 Korea
 - 1 Malaysia
 - 1 India
- +/- 4% distribution (95 %)
- Data to inspire research in order to update standards
- MAP 2.0 will be released Summer 2013

Ideal International Scheme



International Energy Agency 4E Annex-SSL

