IEA 4E SSL ANNEX
LED laboratory comparison - improving testing competency to support market transformation

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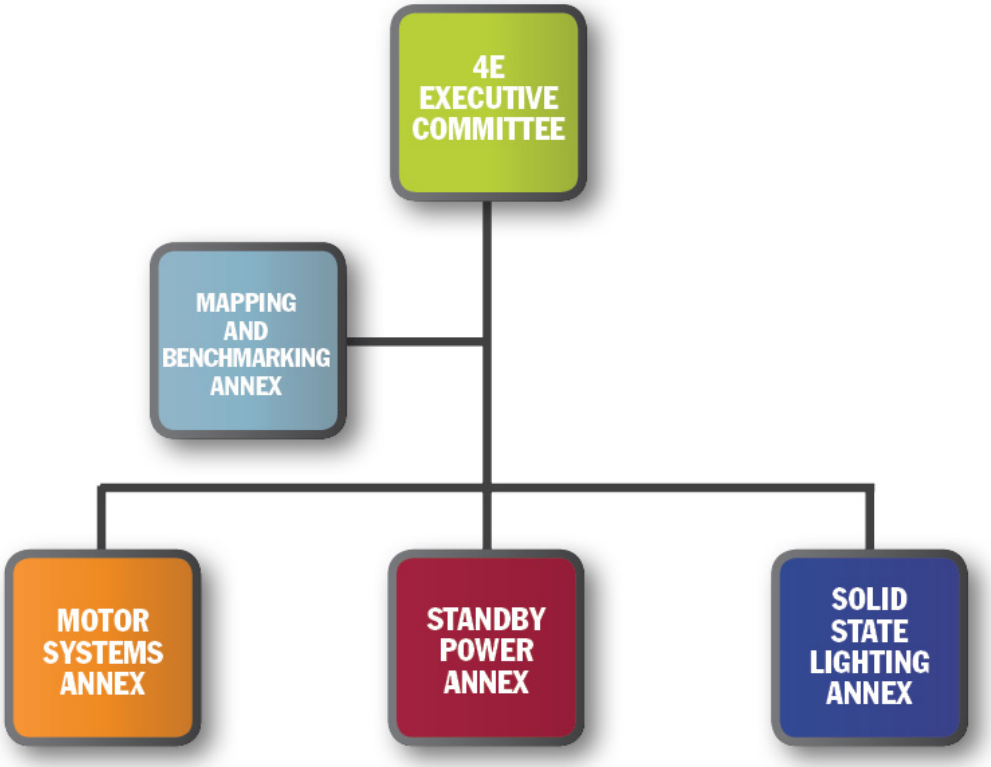
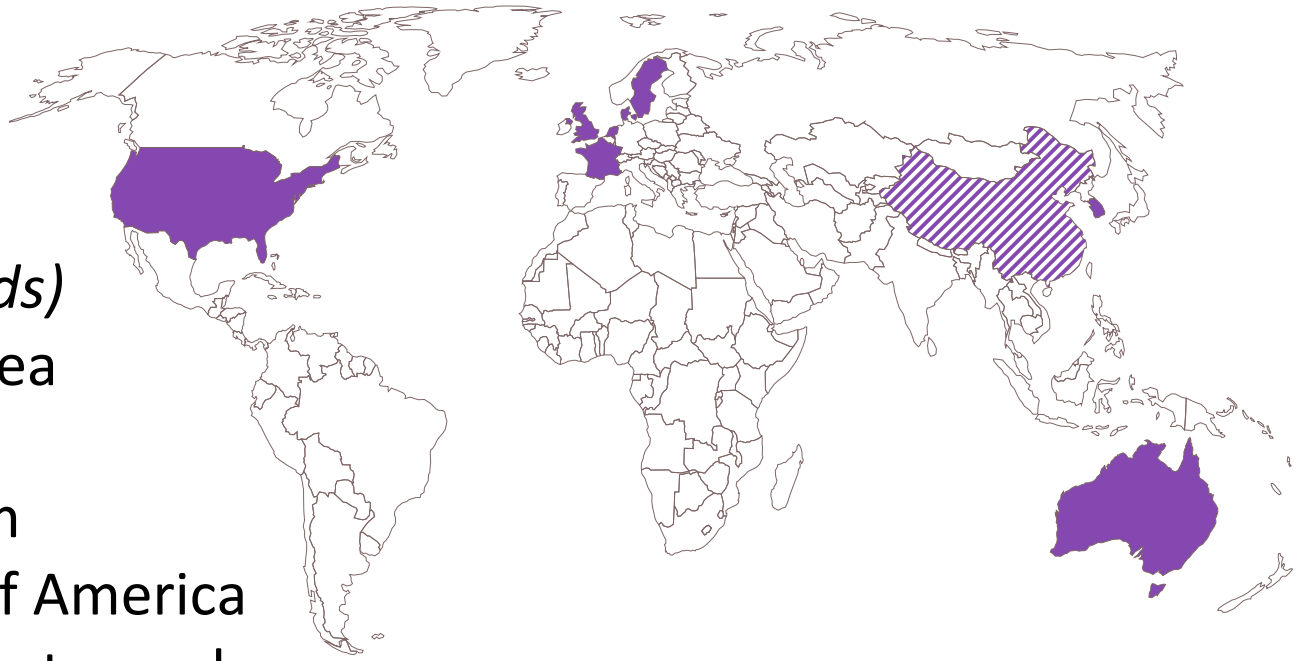
IEA Implementing Agreement: Energy Efficient End-use Equipment



First term: 2009-2014. Second term: 2014-2019
Here focus on the IEA 4E SSL Annex

SSL Annex Member Countries

- Australia
- Denmark
- France
- *(The Netherlands)*
- Republic of Korea
- Sweden
- United Kingdom
- United States of America
- China is an expert member



Goals of the SSL Annex

To provide funding governments with:

- Tools to give guidance and assess SSL *performance*;
- Information *assisting* formation of energy-efficient lighting *policies*; and
- Provision for *harmonised* test procedures and laboratory accreditation.

Overall: ***increase confidence in the SSL and support the acceleration of the market transition to SSL sources.***

SSL Annex 2014-2019 Tasks Clustered by Thematic Groups

- Test Standards and Laboratory Testing – 4 Tasks
- Market Support and Performance – 3 Tasks
- Monitoring, Verification and Enforcement – 3 Tasks
- Communications and Outreach – 1 Task

N.B. Today's talk is about the 2013 Interlaboratory Comparison, a deliverable of 2010-2014 SSL Annex.

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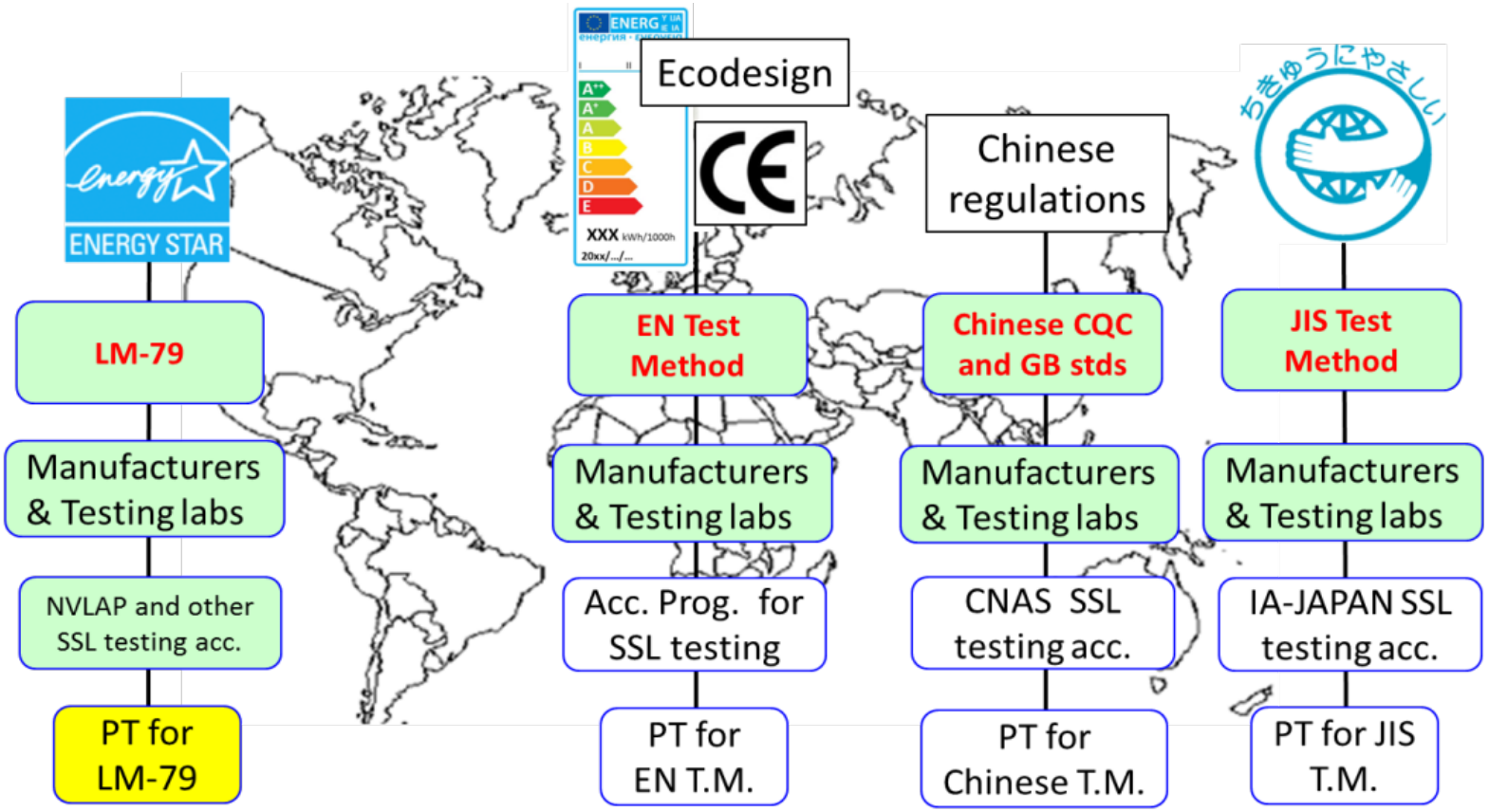
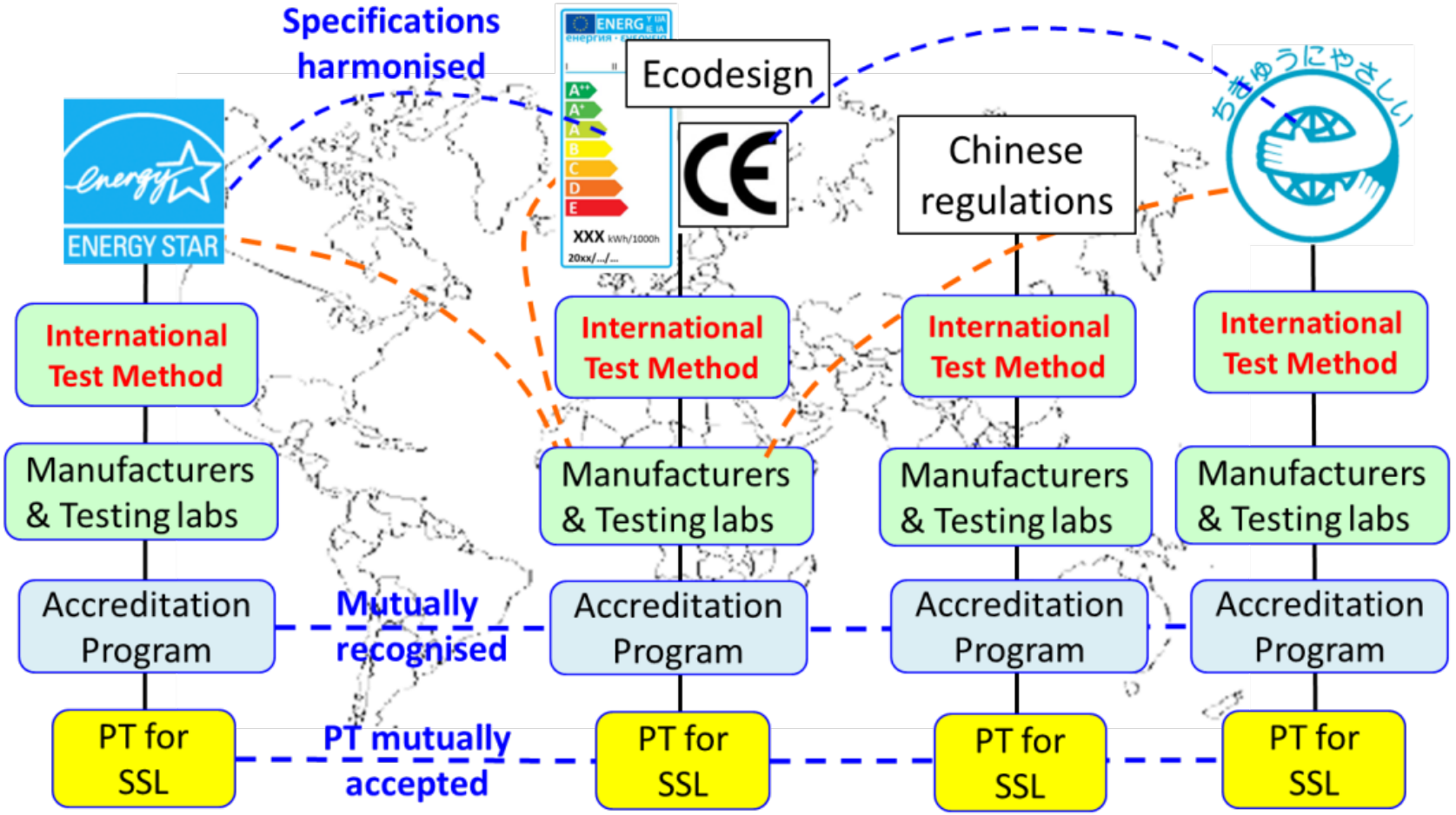
Need for International Harmonisation

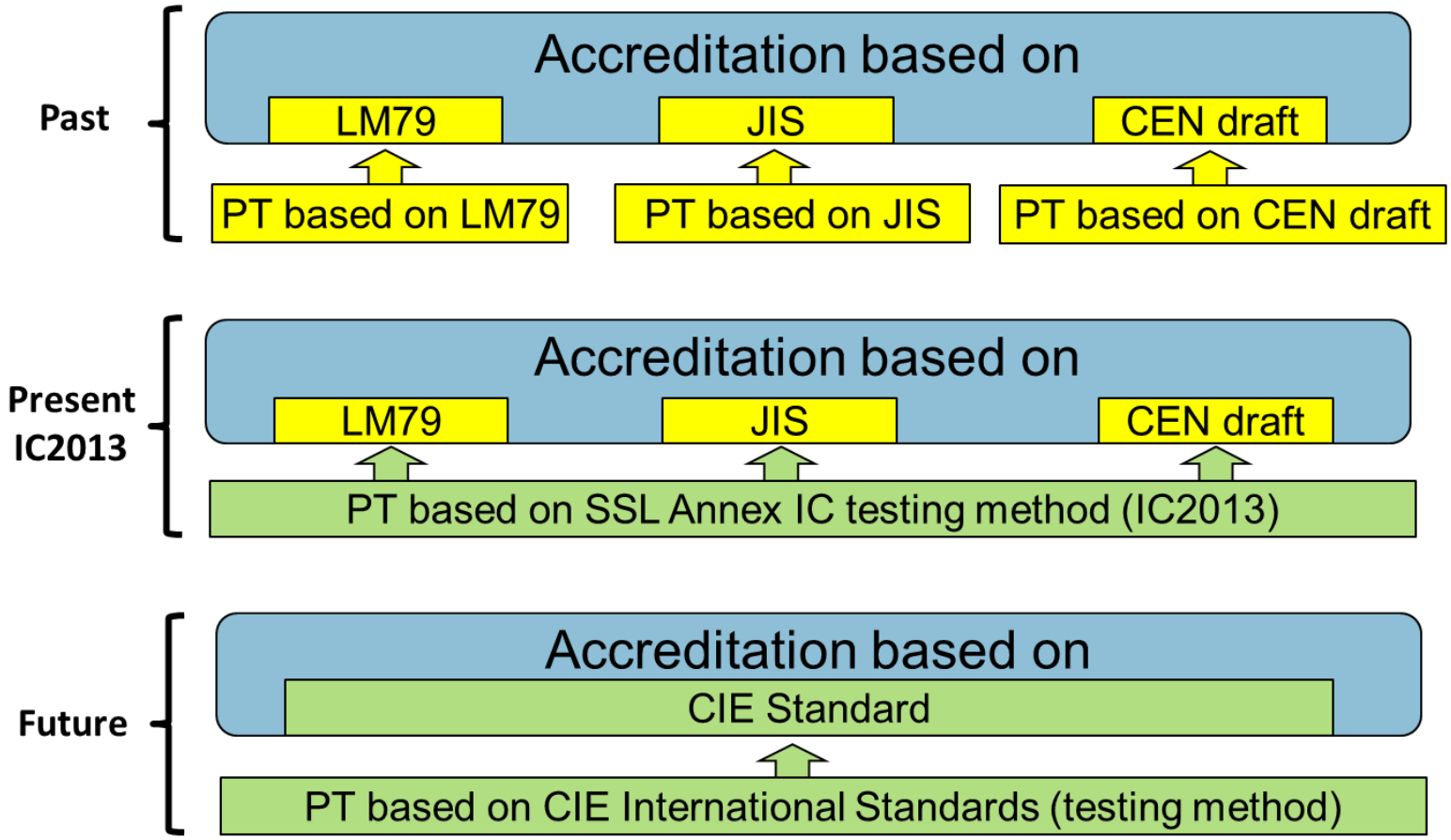


Manufacturers need to obtain accreditation in each region; must pass proficiency test with each accreditation body for different test methods.

Ideal Scheme – Global Harmonisation

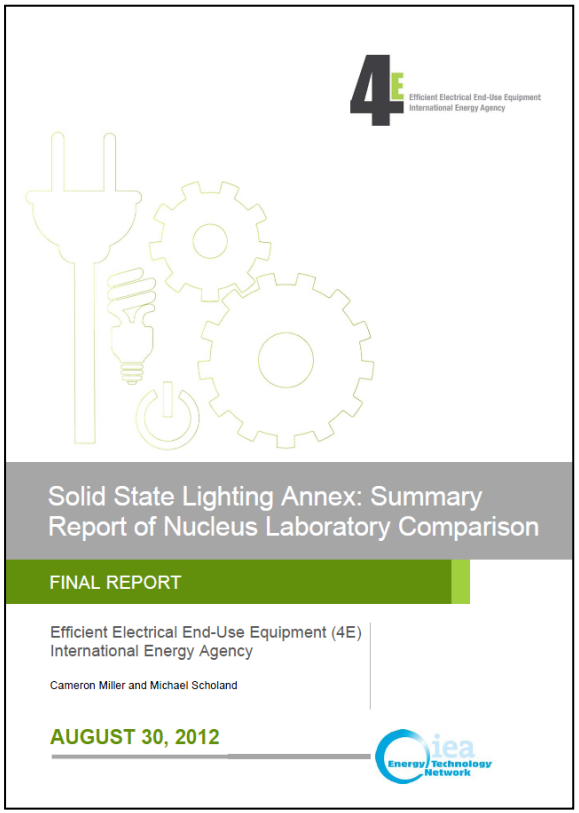


2013 IC is an interim solution….



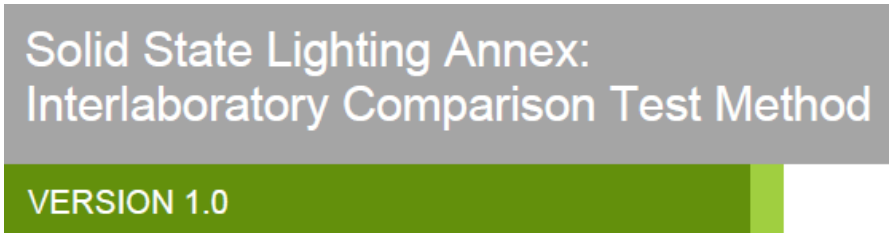
Several Steps in Designing the Programme

- Select the artefact set which will challenge lighting test laboratories
  - Low power factor lamps
  - High correlated colour temperature
  - Directional and non-directional lamps
- Four reference labs (US, CN, JP, NL)
- Established comparability between the reference laboratories (2012)

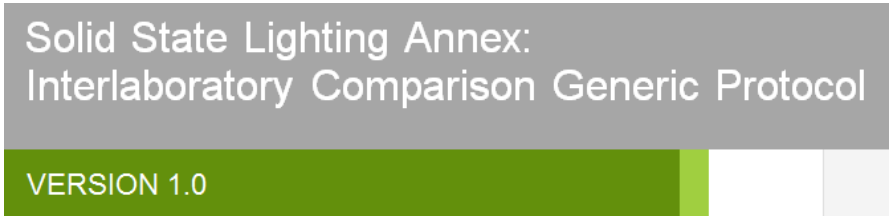


Reports and Documents for the 2013 IC

- Test Method
  15 October 2012



- Generic Protocol
  15 October 2012
  (Regional Protocols)



- Quality Policy (demonstrate conformity to ISO/IEC 17043)

Quality Policy of IEA 4E SSL Annex 2013 Interlaboratory Comparison Tests

The Operation and its conformance to ISO/IEC 17043 of the Nucleus Laboratory Comparison and the 2013 Interlaboratory Comparison Testing conducted by IEA 4E SSL Annex (Draft 1.9)

ISO/IEC 17043 – Conformity Assessment – General Requirements for Proficiency Testing

Interlaboratory Comparison (IC 2013) Timeline

Item	Date
Announcement and opening of application period for participants	22 October 2012
Closure of the application period	30 April 2013
Measurements conducted by the participants	November 2012 – August 2013
Participants Results Reports and Regional Interim Reports issued	January 2014
Final Report of IC 2013 issued to participants	30 June 2014
Final Report of IC 2013 issued to the public	10 September 2014

Participants and Structure

Participated by **54 labs** from **18** countries (paid to participate)

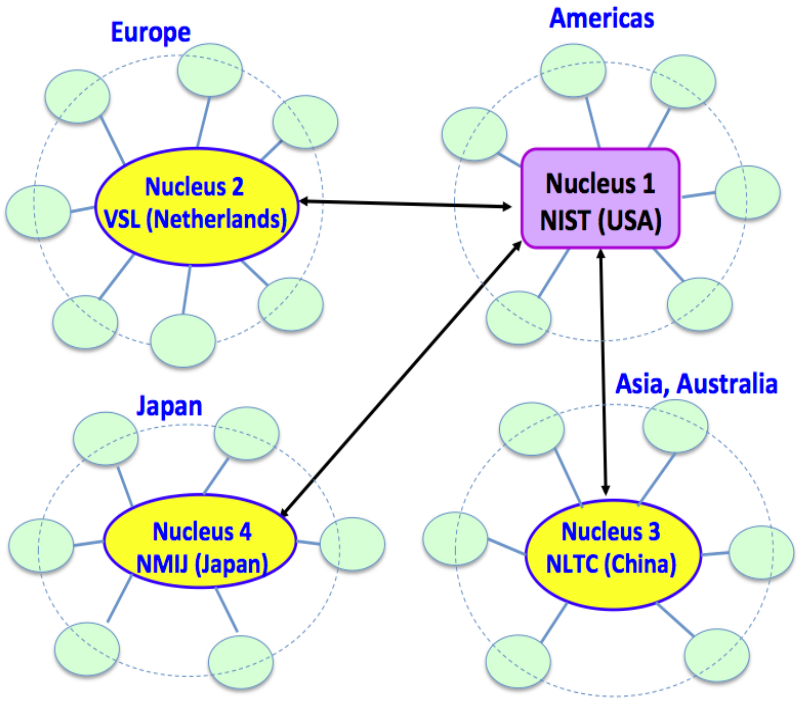
Europe	22;	FR 6, NL 4, SE 3, DK 2, DE 2, UK 2, BE 1, FN 1, RU 1
Asia-Pacific	30;	JP 12, CN 5, KR 5, TW 4, AU 3, NZ 1
Americas	2;	Canada 1, Brazil 1

Plus,

- Data of **35 US labs from NVLAP** (National Voluntary Laboratory Accreditation Program) **and NIST PT** programs for SSL were linked
- Data of **21 labs from APLAC** (Asia Pacific Laboratory Accreditation Cooperation) **Proficiency Test T088** were linked.

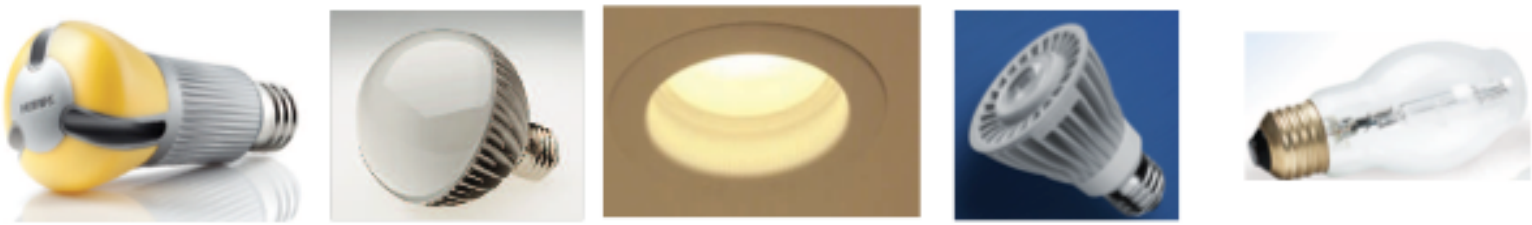
Data of total 110 labs (123 sets of data) were compared.

Comparison was coordinated by **NIST** (Task 2 Leader), and carried out by **four Nucleus labs (VSL, NLTC, NMIJ, NIST)**



IC 2013 – Artefacts and Quantities

- **Four different types of LED lamp** (omni-directional, directional, low power factor, high CCCT) as well as incandescent, also some LED luminaires)



- **Eight quantities** measured: luminous flux, luminous efficacy, active power, RMS current, power factor, chromaticity coordinates x, y, CCT, CRI.

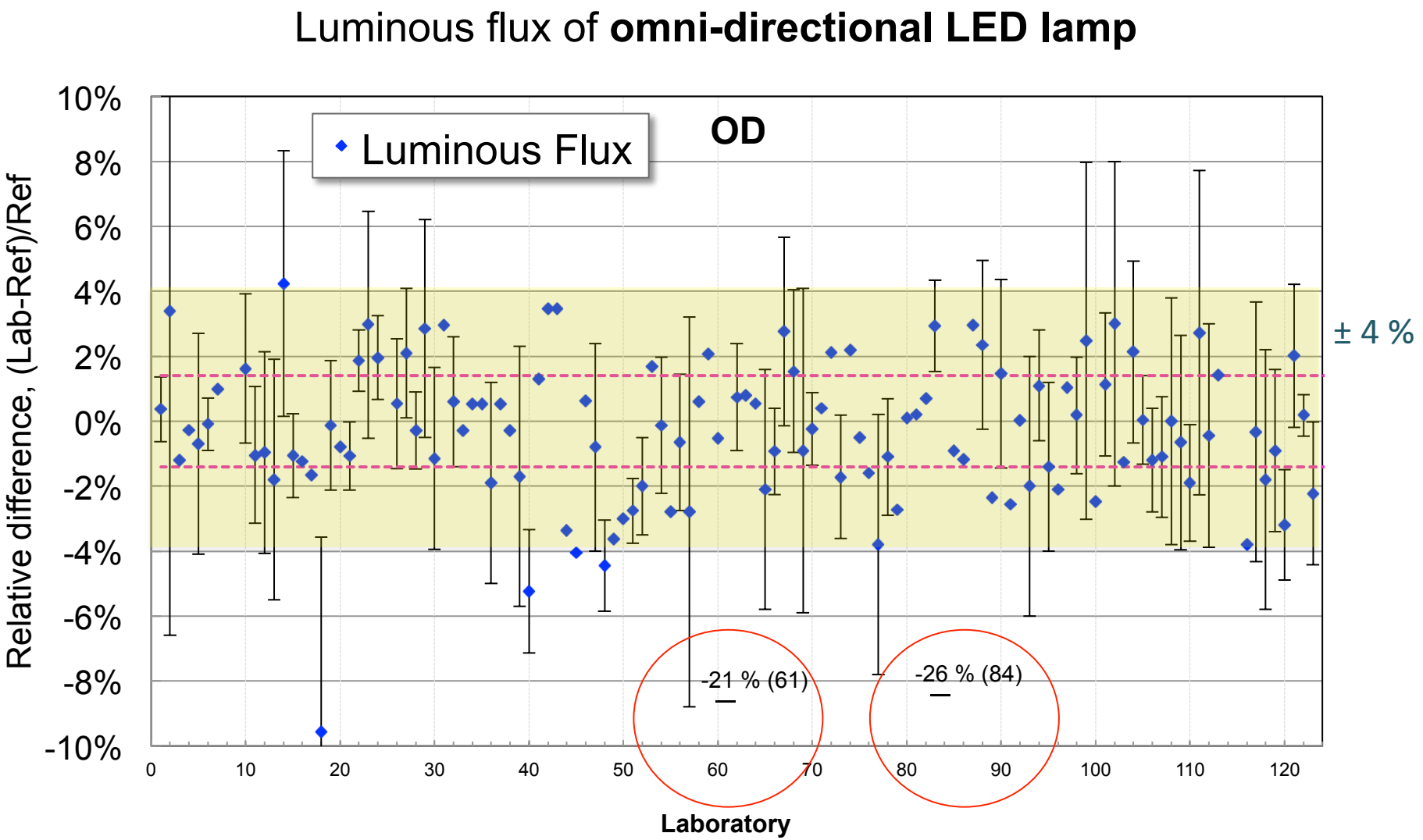
Findings - 1

(1) Good results for most of participants

Luminous flux within ~ ± 4 % (OD) to ± 5 % (D, LPF, HCCT)…
Chromaticity *x*, *y* within ~ ± 0.005.

" These results verified the levels of uncertainty of measurements by laboratories using a well-established test method, and that the test method compiled for the IC 2013 was effective in limiting measurement variations."

Example of Test Results – Flux 1 of 2



Findings - 2

(2) Very large variations of a few participants

"On the other hand, a few extremely large deviations in the results were observed, for example, up to 30 % in luminous flux or up to 0.2 in chromaticity *x, y* in each artefact type. These extreme results must be caused by some major flaws at the participant laboratories in meeting the requirements in the test method."

Findings - 3

Issues with electrical measurement

The variations in the results of RMS current for LED lamps were unexpectedly large, primarily within ± 3 % (OD, D, HCCT) to ± 15 % (LPF) with some deviations **much larger than expected** (up to 38 %), resulting in high values of z' and E_n for many participants.

Findings - 4

Reported uncertainties not reliable in many cases.

Uncertainty evaluation still very difficult for the industry.

Reported uncertainties in very large range. Some laboratories reported **unreasonably small uncertainties** (e.g., 0.0001 in chromaticity x, y) or **unreasonably large uncertainties** (e.g., 10 % in luminous flux or 0.02 in chromaticity x, y). Several laboratories (not those linked) **did not report uncertainties**.

It appears that uncertainty evaluation, especially for colour quantities, is still very difficult for the SSL industry, and reported uncertainties are often not reliable.

Findings - 5

Use of z' values and En numbers

The z' score is suitable for the purpose of *testing laboratory* accreditation, which examines a laboratory's competence and compliance to a test method which is developed to limit measurement variations as is often required in product certification activities.

The E_n number is suitable for the purpose of assessing the validity of claimed uncertainties (e.g., in *calibration laboratory* accreditation).

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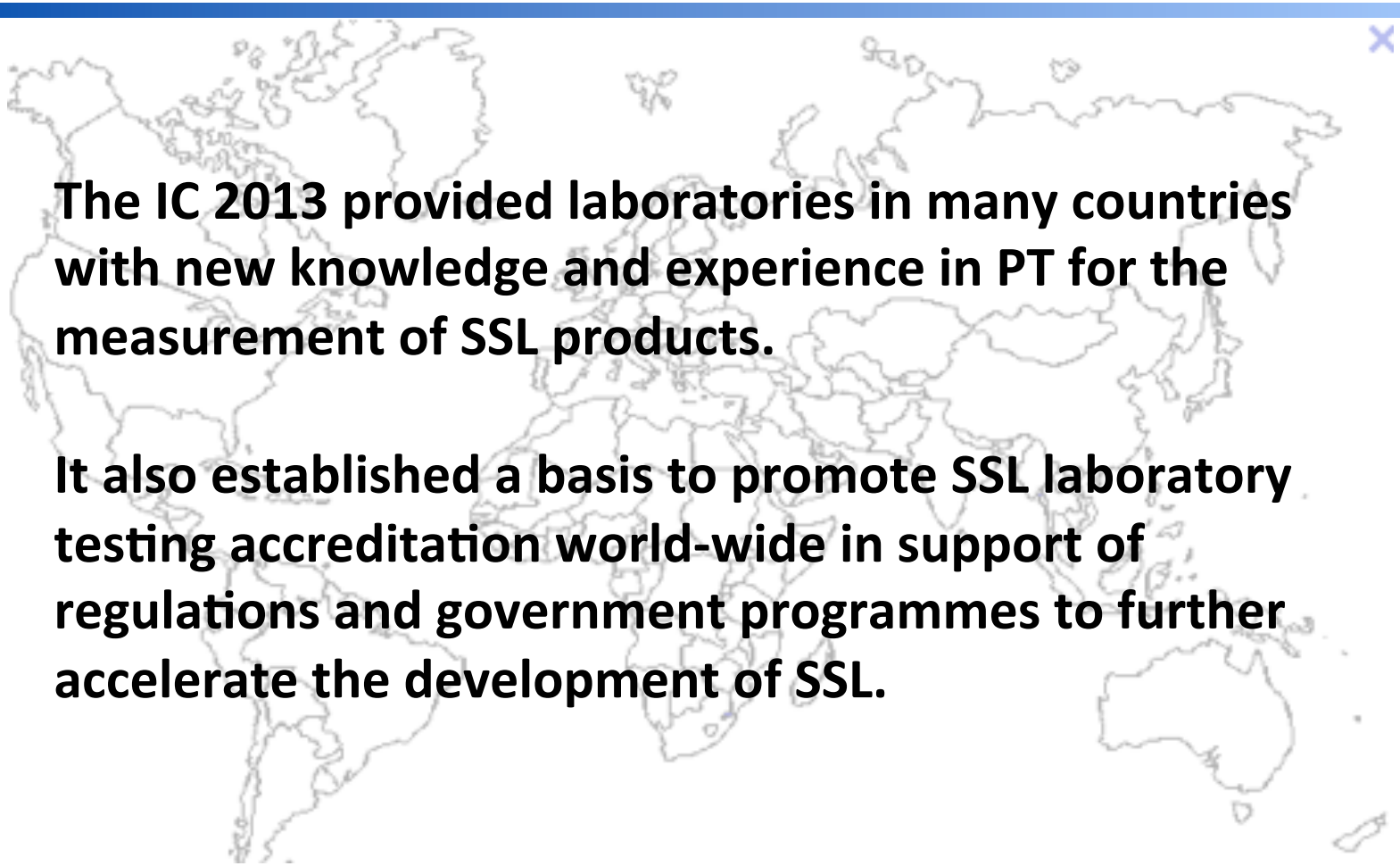
Conclusions (1 of 2)

- Large scale IC 2013 was conducted successfully
- IC 2013 was compliant with ISO/IEC 17043, and has been recognised as a Proficiency Test by NVLAP, IA-Japan, CNAS, KAS, IANZ
- IC 2013 included a comparison of test results from 110 laboratories and 123 sets of data
- Results help governments and manufacturers around the world to learn the uncertainties of the measurements of SSL products and ensure that new products sold to consumers and companies are of high quality and meet the claimed performance.

Conclusions (2 of 2)

- The results also revealed some cases of extremely large errors (e.g., 25 % error in luminous flux)
- Identification of these large deviations for a few laboratories demonstrates the importance of proficiency testing
- The CIE test method CIE S 025/E:2015 was finalised in April 2015 and can now serve as the international test method for SSL products
- SSL Annex is launching a new interlaboratory comparison test scheme – IC 2016 – which will focus on goniophotometers

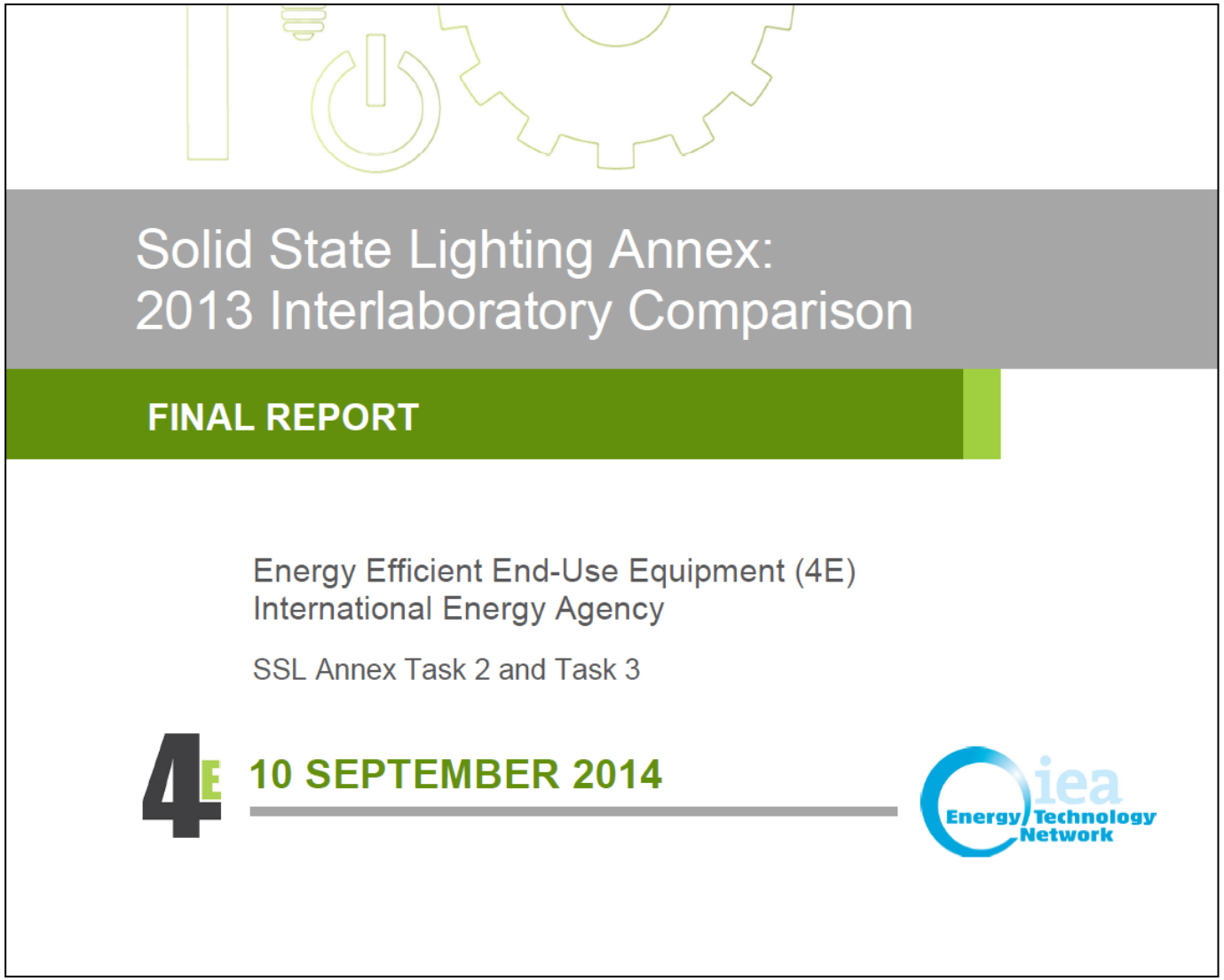
2013 IC achieved its goals…



The IC 2013 provided laboratories in many countries with new knowledge and experience in PT for the measurement of SSL products.

It also established a basis to promote SSL laboratory testing accreditation world-wide in support of regulations and government programmes to further accelerate the development of SSL.

IC 2013 Final Report



http://ssl.iea-4e.org/testing-standards/laboratory-comparability

Thank you for your attention!

- Annex website: http://ssl.iea-4e.org/

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