



European Metrology of Optical Radiation in International Year of Light

3 July 2015 Marek Smid

The International Year of Light and Light-based Technologies 2015





INTERNATIONAL YEAR OF LIGHT 2015

Health Communications Economy









Environment





Overview

The International Year of Light is a cross-disciplinary educational and outreach project with more than 100 partners from over 85 countries

Why Light?

- The science and applications of light creates revolutionary **but often unseen** technologies that directly **improve quality of life** worldwide
- Light-based technology is a major economic driver with potential to revolutionize the 21st century [as electronics did in the 20th century]

The **Proclamation of an International Year of Light** ensures the importance of light and its potential applications are appreciated by all



Activities are very broad - science...



Origin of Life

Healthcare

Communications & GPS

Optical Instruments

The Universe



... and more than science



Cultural Heritage

Education for All

Nature

Light and Art





- Why is metrology important for light-based technologies?
- What is EURAMET doing to support further development in that area?



Metrology for quantum optics and single photon technologies

Quantum key distribution





Why is metrology needed ?

MIQC

Security depends on physical performance of the system when key is created

• Core physical parameters identified for characterisation

Relevant to all technologies operating in single-photon regime



- **IND06: Metrology for Industrial Quantum Communications**
- **Objective**: to develop a pan-European measurement infrastructure to develop standards and characterisation facilities for commercial Quantum Key Distribution (QKD) devices.
- Independent physical characterisation is required to demonstrate that the technology is working within specification
- Focussed on faint-pulse (weak coherent pulse) phase-encoded QKD over fibre at 1550 nm
- <image><image><complex-block><complex-block><complex-block><image><image><table-container><image><table-row><table-row><table-row><table-row><table-row>



Metrology for Industrial Quantum Communications 2

- Development of counter-measures to hacking attacks, and their validation
- Free-space QKD (visible wavelengths)
- Other protocols, e.g. entanglement-based (MDI-QKD, DI-QKD)
- 3-year project
- June 2015 May 2018





Creation of UK's first Quantum Network (UKQN) Device and system trials Integration of quantum and conventional communications Demonstrations

...but single photon technologies have got much broader applications than only QKD



Summary

Single-photon technologies

 Measurements applicable to any technology operating at the single-photon level, not just QKD

QKD

- Development of standard test measurements to **characterise** QKD receiver and transmitter components (MIQC1)
- Informs drafting of ETSI standards for QKD

Future

- Promote development of compact, commercial instrumentation
- Validate counter-measures to hacking attacks (MIQC2)
- Continue input into ETSI standards



Metrology for Innovation in Apearance

What is appearance ?



What is appearance ?



What is appearance ?



What is appearance ?



The visual attributes

(color, texture, gloss, transluscency, fluorescence, sparkle)

- Enrich our perception of the world
- Are involved in the esthetic and the choice of an object



It is essential to control these attributes in the industrial world



Food industry



Cosmetics



Packaging



Architecture real and virtual







Attributes of visual appearance

- Are involved in the esthetic and the choice of an object
- Are a motor of innovation



Measurand (past)



Measurand (past)





Standard artefacts



Spectroradiometer

Measurand (past)



Measurand (past)



Measurand (today)



Measurand



Topics



The BRDF is the relevant quantity to characterize the appearance of an object

Facility Goniospectrophotometer

Before 2005 NIST, PTB, NPL Today

<u>CIRL, CNAM, CSIC, INRIM</u>, ITRI, KRISS, <u>MIKES, PTB, PTB2, CMI</u>, NIST, NPL, NRC



Young and complexe facilities



What are we doing in xDReflect?

We (want to) develop metrics and tools **to quantify** the appearance of the surfaces

Outputs

- "Key comparisons" of primary measurements capabilities for BRDF
- Standard measurement procedures for gonichromatism, gloss, sparkle and fluorescence.
- Transfer artefact for special visual effect
- Models and data handling methods for BRDF measurement
- Correlation between the visual appearance and the BRDF



Outputs

- key comparisons of primary measurements capabilities for BRDF
- Standard measurement procedures for gonoichromatism, gloss, sparkle and fluorescence.
- Transfer artefact for visual effect
- Models and data handling methods for BRDF measurement
- Correlation between the visual appearance and the BRDF

Impact

- Development of new equipment by instrument manufacturers
- Development of new samples for artefact manufacturers
- Birth of a "culture" of visual effect measurement values
 - Reduction of costs related with production of prototypes or pre-products

Outputs

Impact

- key comparisons of primary measurements capabilities for BRDF
- Standard measurement procedures for gonichromatism, gloss, sparkle and fluorescence.
- Transfert artefact for special visual effect
- Models and data handling methods for BRDF measurement
- Correlation between the visual appearance and the BRDF

- Easy to use measurements
- Better knowledge of the border between "the things that are seen" and "the things that are not seen"
- Improvement of client-supplier relations because based objective basis, through requirements and specifications that can be controlled scientifically and checked objectively at the delivery level.





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Thank you!