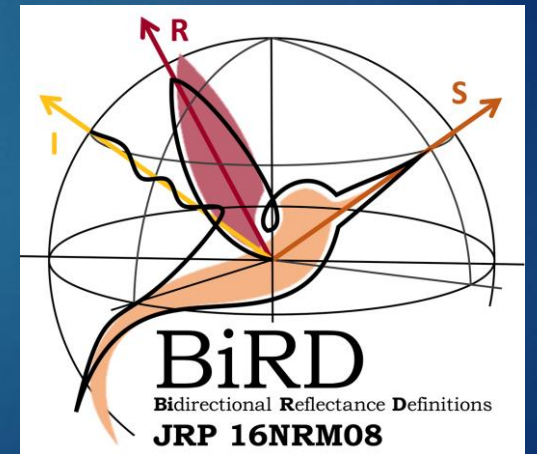
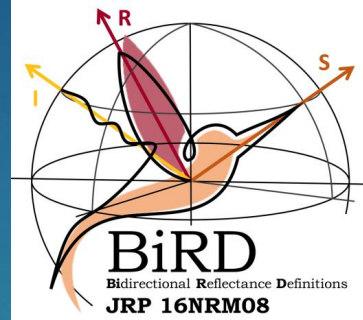


Overview of the European project “Bidirectional reflectance definitions”

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“Bidirectional reflectance definitions” (BiRD, 16NRM08)

- JOINT RESEARCH PROJECT (9 NMIS & 2 UNIVERSITIES + 25 COLLABORATORS)
- EUROPEAN PROGRAM FOR METROLOGY, EMPIR
- [HTTPS://WWW.BIRDPROJECT.EU/](https://www.birdproject.eu/)

EMPIR: European metrology program for innovation and research

- ▶ **Integrated part of Horizon 2020**, the current EU Research and Innovation program.
- ▶ Organizes the **cooperation** of European institutes of metrology (members of EURAMET), industry, academia, standardization bodies, etc. in **Joint Research Projects**.
- ▶ To target the needs of industry in the field of metrology and accelerate dissemination of research outputs and innovative products to market.
- ▶ An allocated total budget of 600 M€, 50% from the European Commission and 50% from the participating countries (Art. 185 of the Lisbon Treaty).
- ▶ **Period: 2014 to 2020** (7 annual calls).

EMPIR Targeted areas

Priority areas to address the EU's societal Grand Challenges in:

- ▶ Health
- ▶ Energy
- ▶ Environment
- ▶ Industry
- ▶ **Pre and Co-Normative**
- ▶ Progress of fundamental measurement science.

Normative Joint Research Projects

- ▶ The aim is to develop traceable measurement methods and metrological techniques required for standardisation.
- ▶ Particularly, the needs of European and International Standards Organisations for measurement research, in any area.
- ▶ Contributing to the current standardisation work program but also to new topics necessary to feed any future standardisation work.

Bidirectional Reflectance Definitions (16NRM08, BiRD)

This project focuses on the pre-normative work required to clarify how bidirectional reflectance measurements on standard materials and surfaces exhibiting gonio-chromatism, gloss and sparkle visual effects should be carried out.

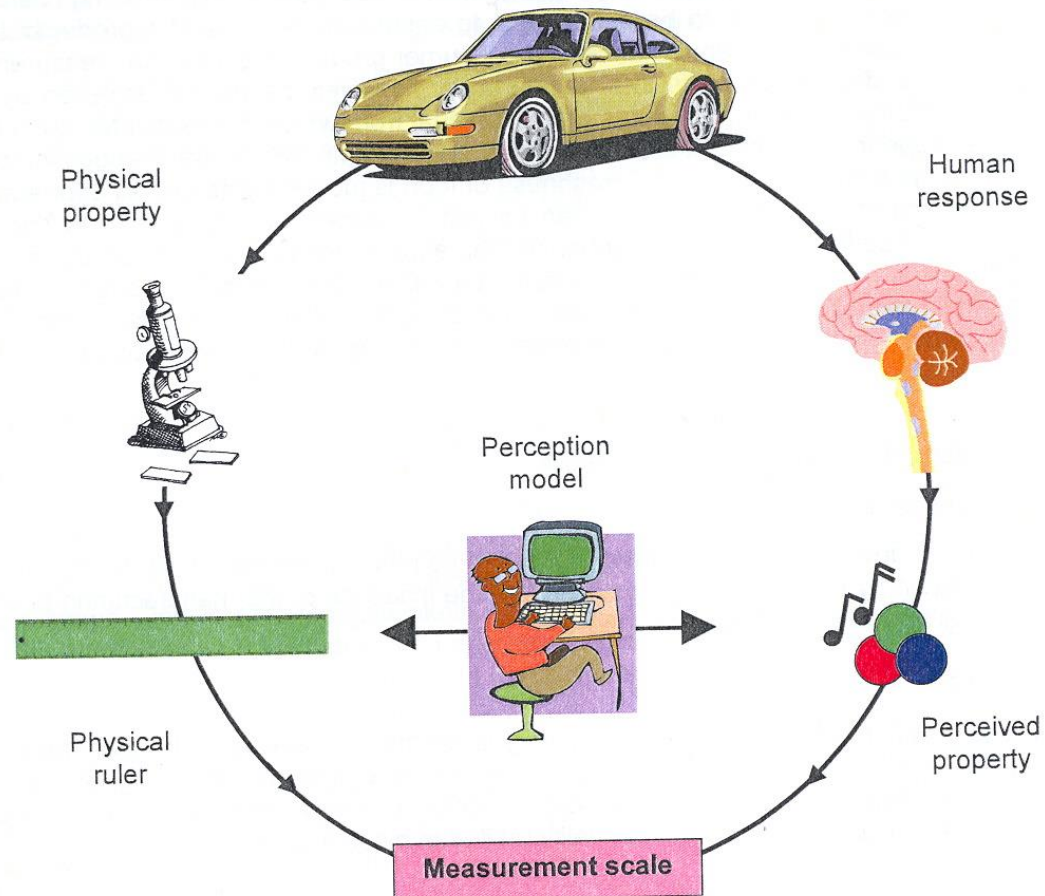
Guidance will be developed on measurements of BRDF, BRDF sampling strategy and arrangements for BRDF data sampling, processing and visualisation according to the visual effect.

Why this project?

- ▶ The commercial success of a product is often dependent on its aesthetic appearance. For this reason, different industrial sectors e.g. automotive coatings, cosmetics, printed materials, are continuously looking to develop new attractive visual effects.
- ▶ Appearance control: Quality control level (constancy and reproducibility of manufacturer's production) and at the commercial level (e-commerce).
- ▶ We have to measure appearance (as you already know).

Measurement of Appearance: How?, It is a perception!

Standardized
quantities
describing
light-matter
interaction



Appearance
visual attributes
excluding
geometrical
aspects

Attributes of appearance



COLOUR

Modification of spectral distribution



GLOSS

Specular reflection at the front of the object



SPARKLE

Texture dependent on direction



Fluorescence

Addition of spectral content

APPEARANCE



SURFACE TEXTURE

Spatial variation in reflection or transmission

TRANSLUCENCY

Transmission through the object

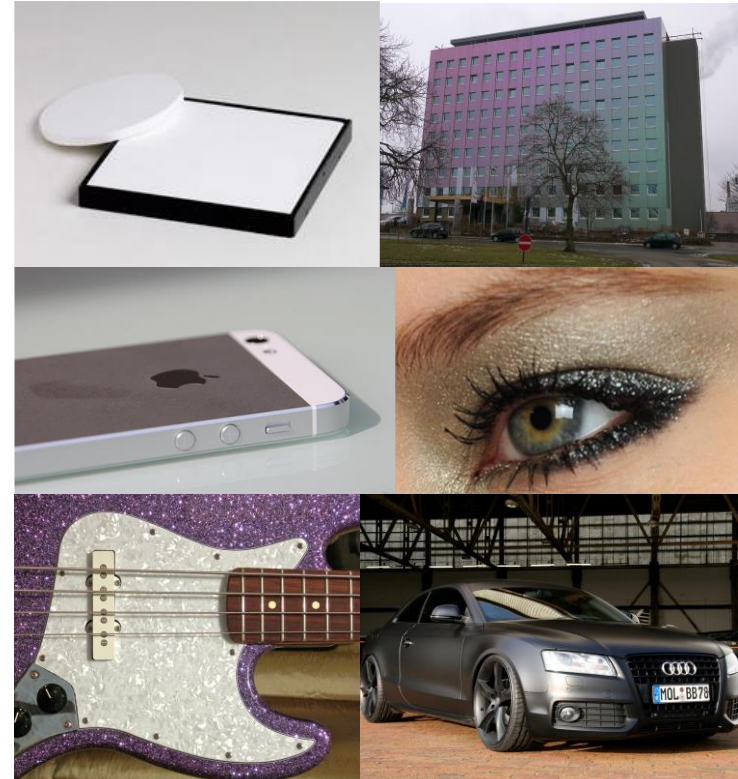


Standardized measurements at present



Color : ISO 11664-xx, CIE S-014-xx, some ASTM

Gloss: ISO 2813, several ASTM

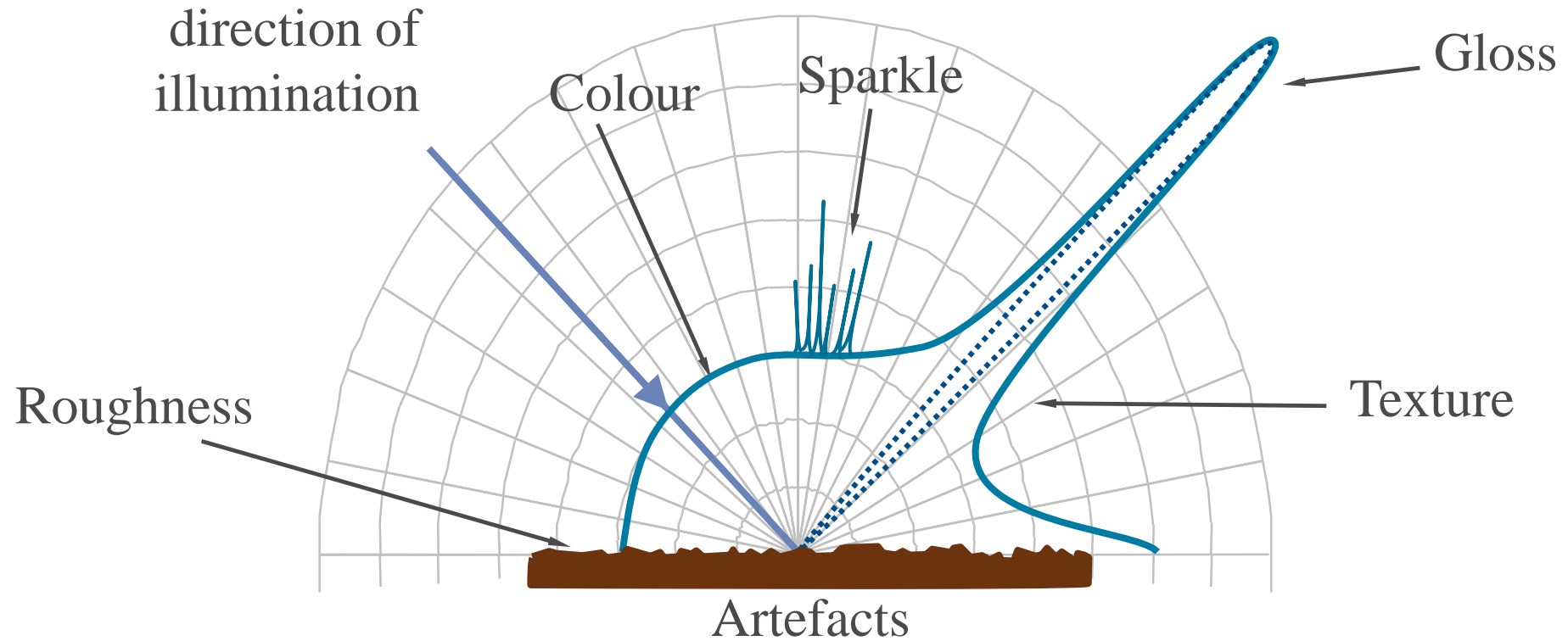


Evolution (measurand and something else)

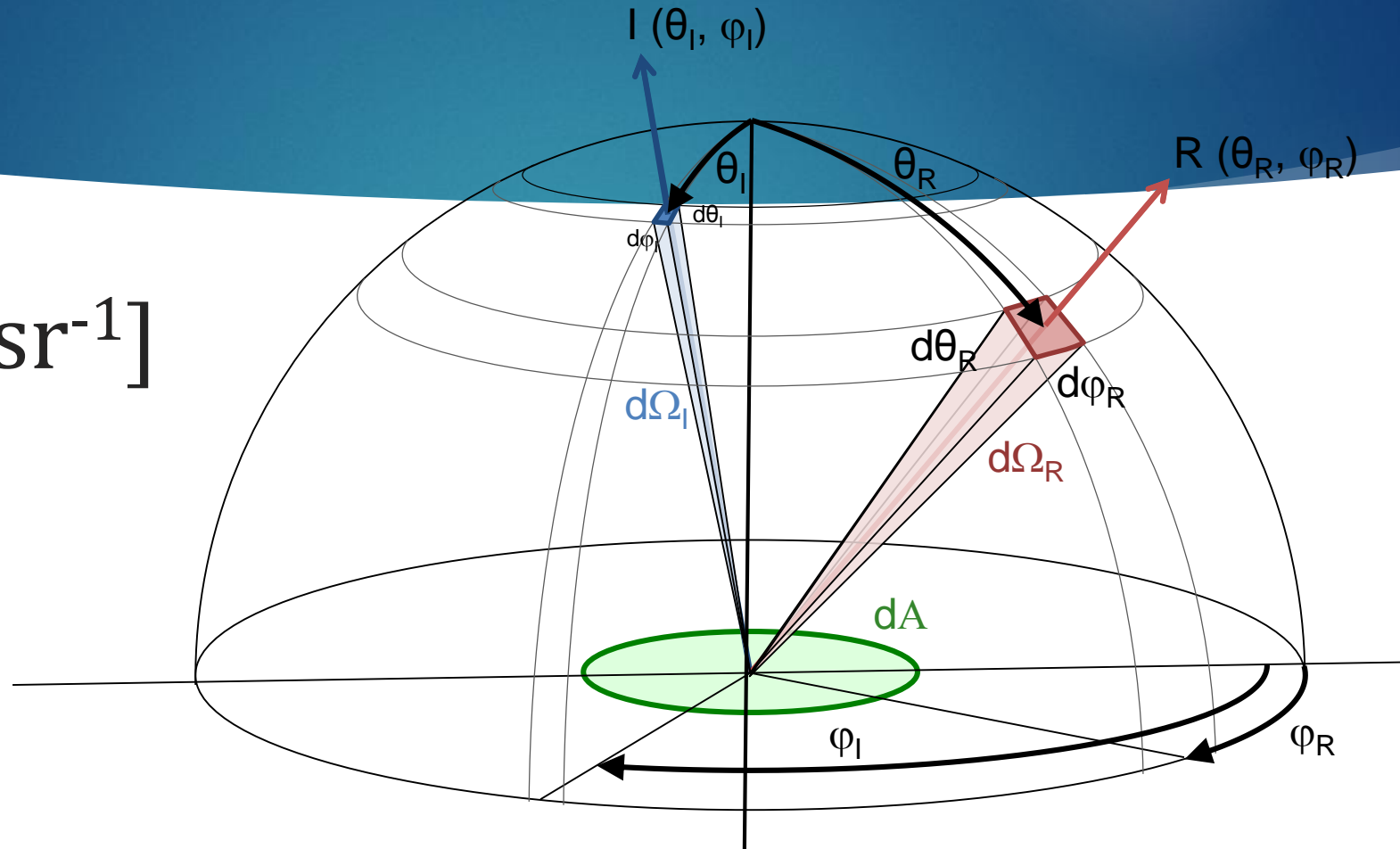
- ▶ Development of a metrology of appearance to provide references, traceability, standard artefacts and methods.
- ▶ Normalization of the quantity to allow development of new instrumentation adapted to current measurand.
- ▶ Perceptual scales with more significance to the users.

Too much for a single Project!

What should be the measurand?



BRDF [sr⁻¹]



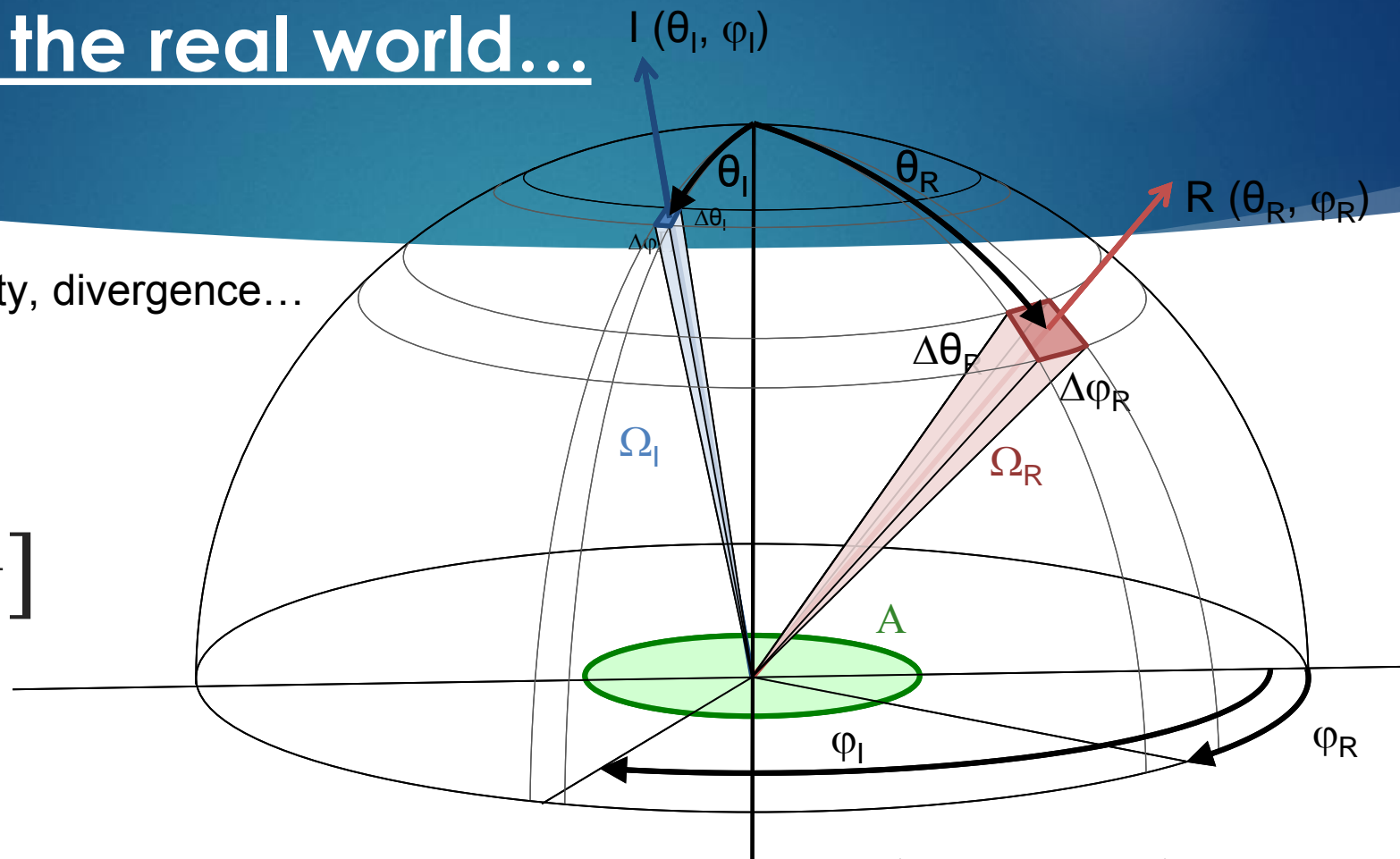
$$f_{e,\lambda}(\theta_i, \varphi_i, \theta_r, \varphi_r, \lambda) = \frac{dL_{e,\lambda,r}(\theta_i, \varphi_i, \theta_r, \varphi_r, \lambda)}{dE_{e,\lambda,i}(\theta_i, \varphi_i, \lambda)}$$

But in the real world...

Incident beam uniformity, divergence...

FOV detection...

BRDF [sr⁻¹]



$$f_{e,\lambda}(\theta_i, \phi_i, \theta_r, \phi_r, \lambda) = \frac{\Phi_{e,\lambda,r}(\theta_i, \phi_i, \theta_r, \phi_r)}{\Phi_{e,\lambda,i} \cdot \Omega_r \cdot |\cos \theta_r|}$$

BiRD: Recommendation for BRDF measurements

- ▶ To agree on the definition of a finite number of categories according to the BRDF properties (e.g. quasi-lambertian, glossy, textured, goniochromatic), and to define the angles of illumination and detection.
- ▶ To propose a minimal requirement of the optical setting for the illumination and detection beam, enabling the characterisation of the sample.
- ▶ To study the effect of the size and shape of the measurement area on BRDF measurements and to propose recommendations of requirements for size, shape and uniformity of the illuminated area according to the type of sample under investigation.

BiRD: Recommendation for BRDF measurements (cont.)

- ▶ To study the influence of polarization and fluorescence on BRDF measurements and on uncertainty, and to propose recommendations on how to deal with the influence of these side-effects.
- ▶ To investigate and propose a sampling strategy of the BRDF and to provide an estimate of the error made in the reconstruction of the full BRDF based on the restricted set of measurement points.
- ▶ To prepare the technical recommendation on BRDF measurements which will be based on the previous work.

BiRD: BRDF data handling and visualisation

- ▶ To propose a universal BRDF file format.
- ▶ To provide pertinent appearance descriptors extracted from raw BRDF data.
- ▶ To propose a basic free applet for BRDF visualisation and management.

BiRD: Gloss

- ▶ To review the state of the art on gloss measurement and perception: database of key research articles, specific terminology related to gloss perception and gloss measurement.
- ▶ Establishment of a CIE TC on gloss.
- ▶ Acquisition of parameters on the physical nature of gloss.
- ▶ To investigate the influence of illumination field, surface colour, and lighting environment on the perception of gloss.
- ▶ Recommendations for the physical and visual evaluation of gloss.

BiRD: Sparkle and graininess

- ▶ To establish a new CIE TC on the characterisation of sparkle and graininess of coatings.
- ▶ To define sparkle and graininess measurands and to propose an image-based procedure for the measurement of sparkle and graininess.
- ▶ Testing the existing measurement capabilities of NMs for sparkle and graininess.

BiRD: Sparkle and graininess (cont.)

- ▶ To propose a measurement scale and visual scale for sparkle and graininess, developed from the correlation between the human perception and the measured sparkle/graininess quantities.
- ▶ To agree on the most appropriate measurement procedures and visual scales for sparkle and graininess.

How are we
doing in BiRD up
to date?

YOU WILL SEE IN MORE
DETAIL IN THIS WORKSHOP
FOR SOME ITEMS

Standardization

TC2-85

Chair: Gaël Obein (FR)

Title

Recommendation on the geometrical parameters for the measurement of the Bidirectional Reflectance Distribution Function (BRDF).

Terms of reference

To provide geometrical recommendations for the BRDF measurement according to the type of sample under investigation, in order to allow better comparison between the different instruments, to improve the traceability of the measurements, and to help the user to choose the right angular configuration.

Standardization

JTC 12 (D1/D2/D8)

Chair: Alejandro Ferrero (ES)

Title

The measurement of sparkle and graininess

Terms of reference:

To provide a methodology to measure sparkle and graininess, and to develop a measurement scale. Measurands will be defined and the requirements for their measurements will be well normalized, in such a way that different instruments can provide the same spectrophotometric data from the same specimen. A psychophysical method will be recommended to obtain visual data, and its correlation with the spectrophotometric data will be worked out to develop the measurement scale for sparkle and graininess.

Standardization

JTC 17 (D1/D2/D8)

Chair: Frederic Leloup (BE)

Title

Gloss measurement and gloss perception: A framework for the definition and standardization of visual cues to gloss.

Terms of reference

To describe recommendations for standardised visual assessment conditions of individual, established cues to gloss, to make recommendations for the definition of a standard gloss observer for individual diagnostic cues and, based on the findings from the above, to suggest optical methods and metrics for describing gloss in correlation with the established gloss cues.



Partnership

le cnam

A!



Aalto-yliopisto



CSIC

RISE



KATHOLIEKE UNIVERSITEIT LEUVEN

METAS



Joaquin Campos

Workshop on Visual Appearance

COLLABORATORS AND SUPPORTERS



KONICA MINOLTA



ŠKODA



Alicante 29-May-19

Thank you very
much for your
attention