EMPIR: European metrology program for innovation and research

▶ **Integrated part of Horizon 2020,** the current EU Research and Innovation programme.

▶ Organizes the **cooperation** of European institutes of metrology (members of EURAMET), industry, academia, standardisation 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 programme 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 know).

Appearance is a perception

Quantities describing light-matter interaction
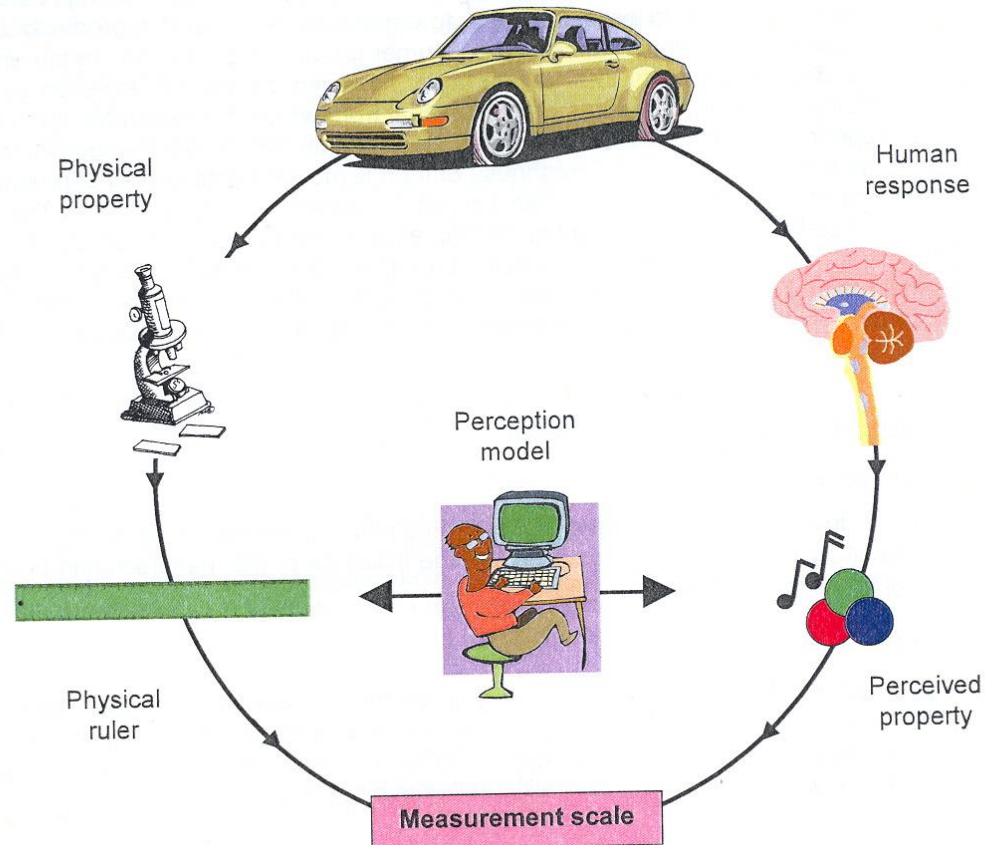
Appearance visual attributes excluding geometrical aspects

Attributes of appearance

COLOUR
Modification of spectral distribution

GLOSS
Specular reflection at the front of the object

SPARKLE
Texture dependent on direction

APPEARANCE

Fluorescence
Addition of spectral content

SURFACE TEXTURE
Spatial variation in reflection or transmission
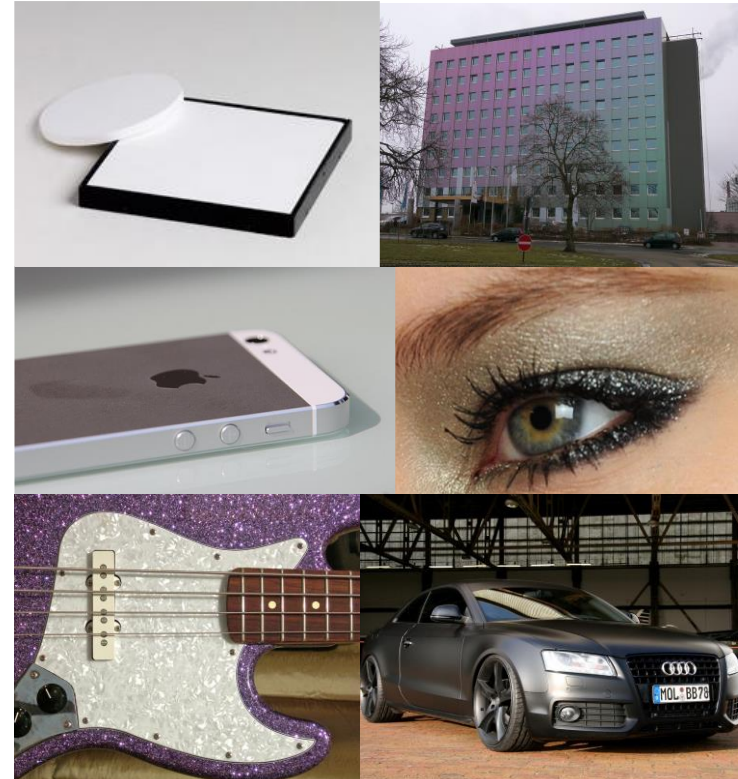
TRANSLUCENCY
Transmission through the object

Measurand

Color : ISO 11664-xx, CIE S-014-xx
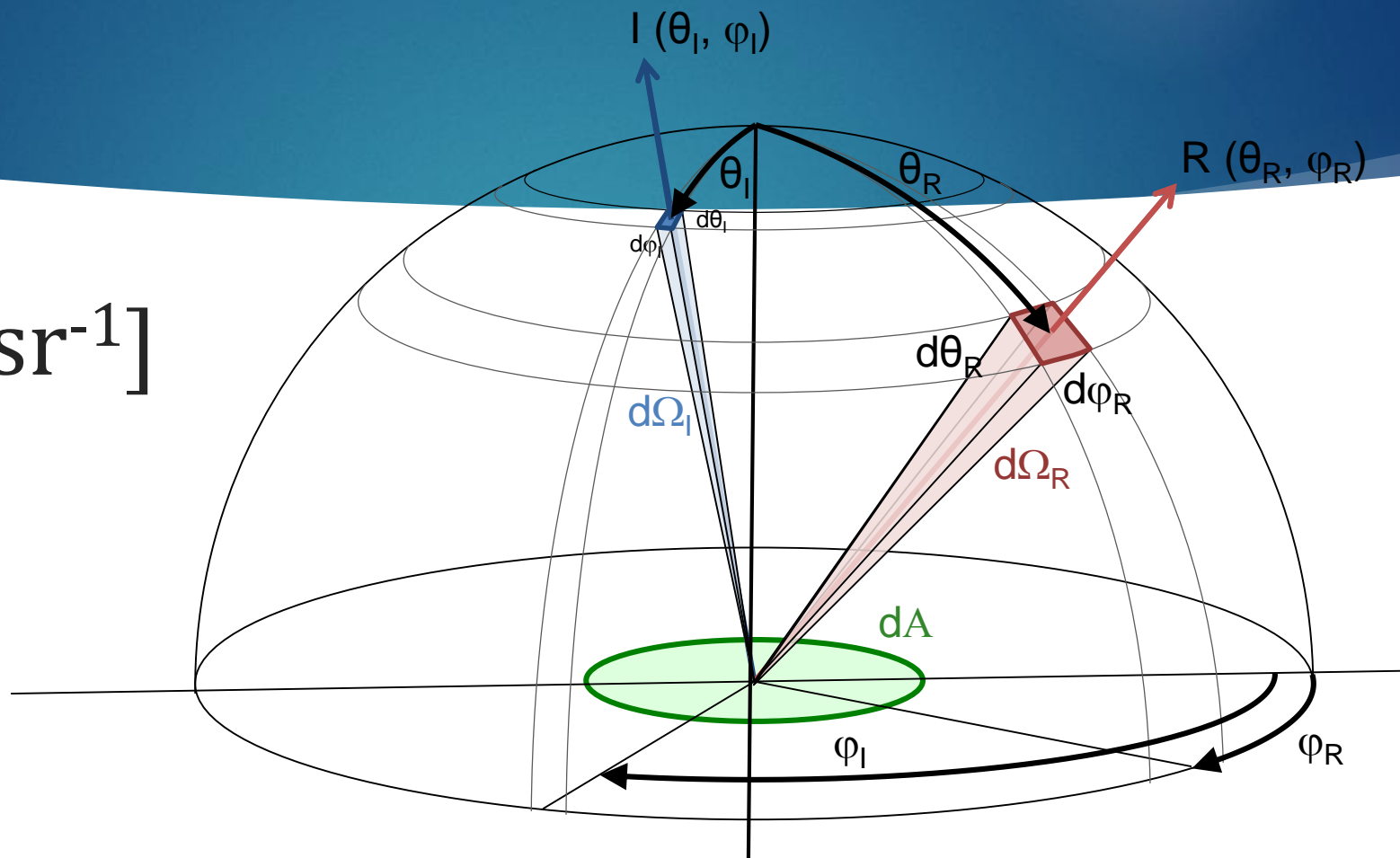
Gloss: ISO 2813, several ASTM

Measurand and … (something else)

- Development of a metrology of appearance to provide references, traceability, standard artefacts, methods.

- Normalization of the quantity to allow development of new instrumentation adapted to current measurand.

- Perceptual scales with more significance to the users.
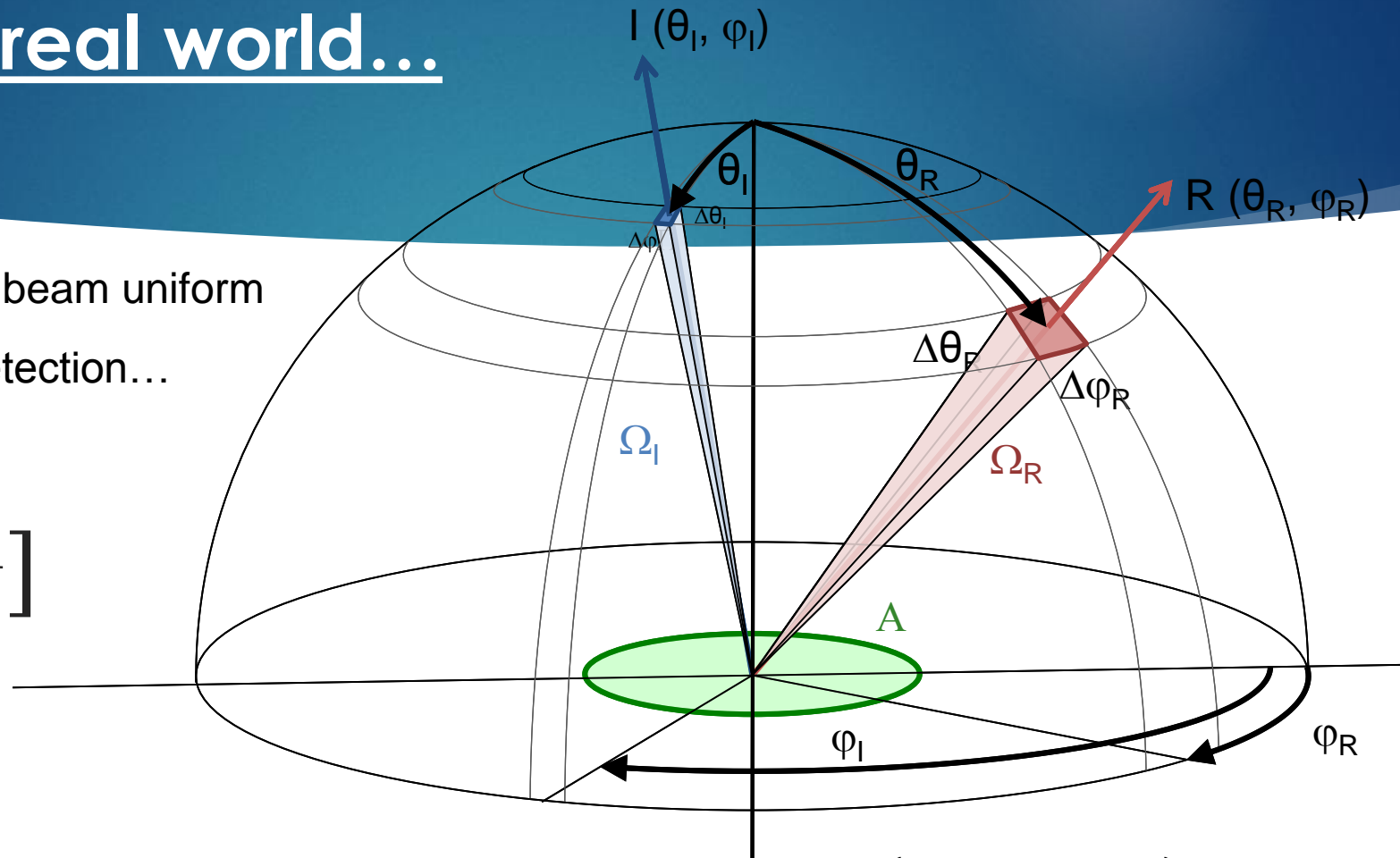
Too much for a single Project!

Measurand
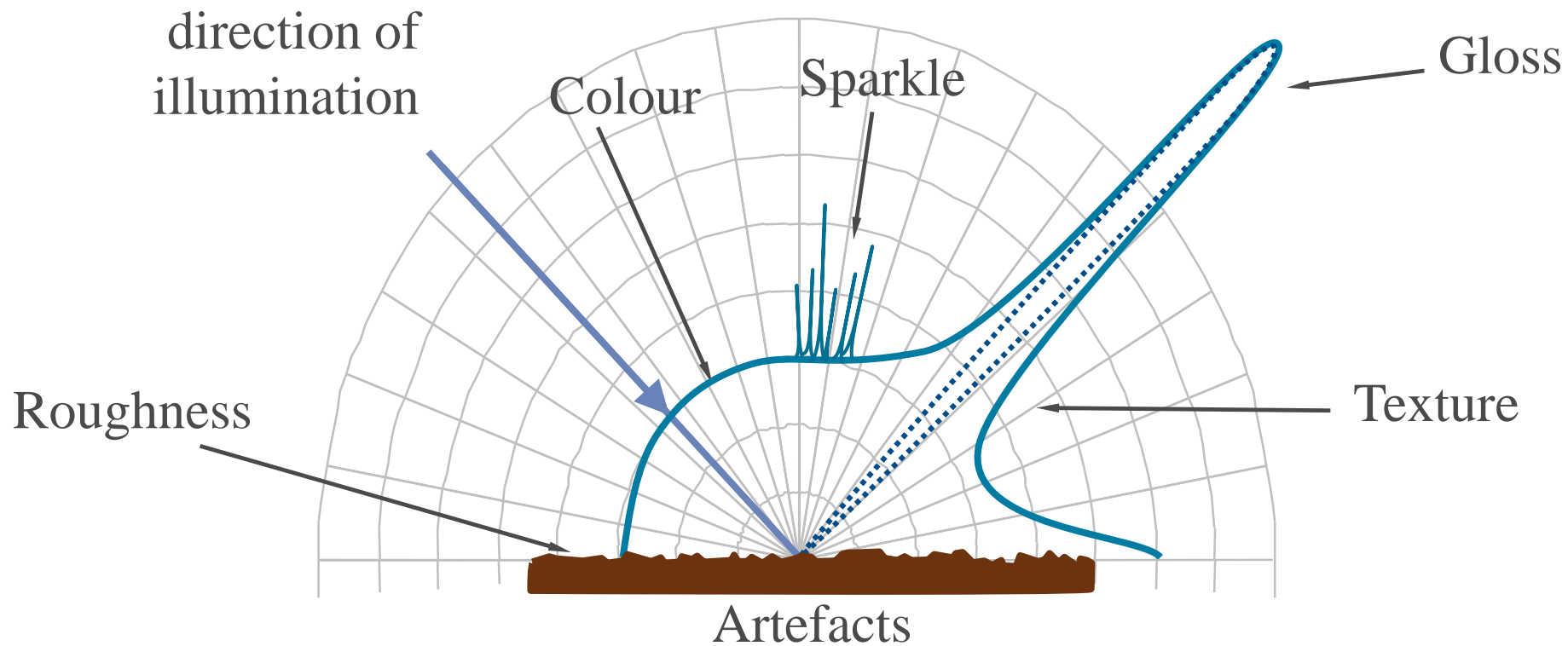
BRDF $[sr^{-1}]$

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

Joaquin Campos.   Instituto de Óptica (CSIC)

But in the real world…

Incident beam uniform

FOV detection…

BRDF [sr⁻¹]

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

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 polarisation 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 establish a universal BRDF file format.

▶ To provide pertinent appearance descriptors extracted from raw BRDF data.

▶ To propose a basic free applet for BDRF 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 NMIs 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.

Standardisation

TC2-85

(created on December 2015)

Title

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

Term 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.

Partnership

On their behalf, we ask you for inputs about:

➢ DEFINING SAMPLE CATEGORIES.

➢ DEFINING CATEGORIES OF GONIO-SPECTROPHOTOMETERS.

➢ DEFINING THE ANGLES.

➢ FOR EACH CATEGORY OF SAMPLE:

- Recommendation for the incident beam (shape, divergence)

- Recommendation for illuminated area (size, shape, uniformity, etc.)

- Recommendation for solid angle of measurement.

- Recommended for sampling and angular configuration.

Thank you very much for your attention