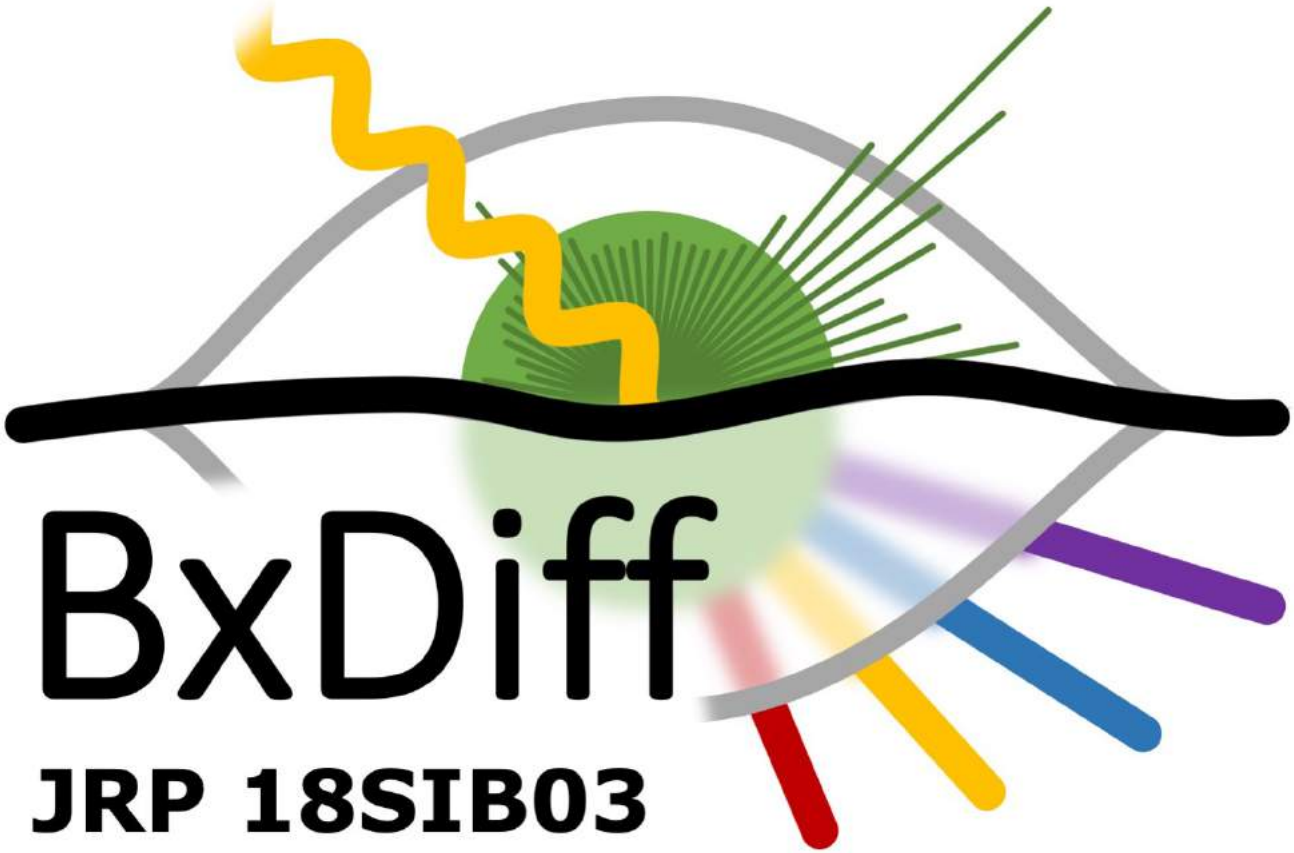
EMPIR EURAMET
The EMPIR initiative is co-funded by the European Union's Horizon 2020 research and innovation programme and the EMPIR Participating States

le cnam



Kick – off meeting

CNAM — St Denis (FR) — 22th/23th May 2019

BxDiff
JRP 18SIB03

LNE le cnam

Welcome to CNAM

MADE IN cnam since 1794

Gaël Obein

(Associate professor at CNAM)

Opening

BxDiff

JRP 18SIB03

May 2019 → **Avril 2022**

The measurement of appearance

Definition of the measurand

Appearance is the visual sensation through which an object is perceived to have attributes such as size, shape, colour, texture, gloss, transparency, opacity, etc.

CIE 175:2006

Colour

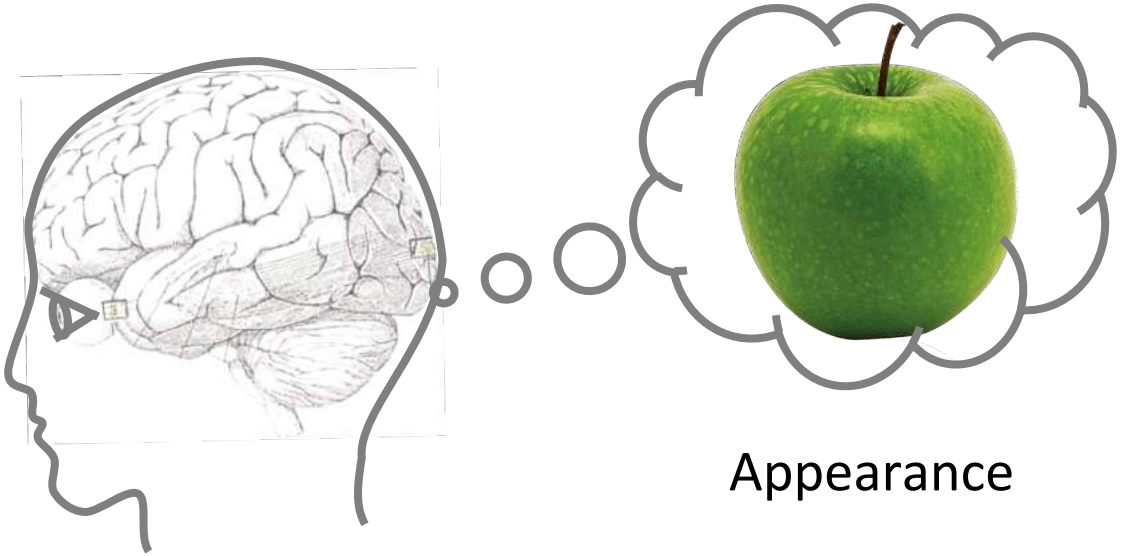
Texture

Gloss

Translucency

The measurement of appearance

Physical Stimulus

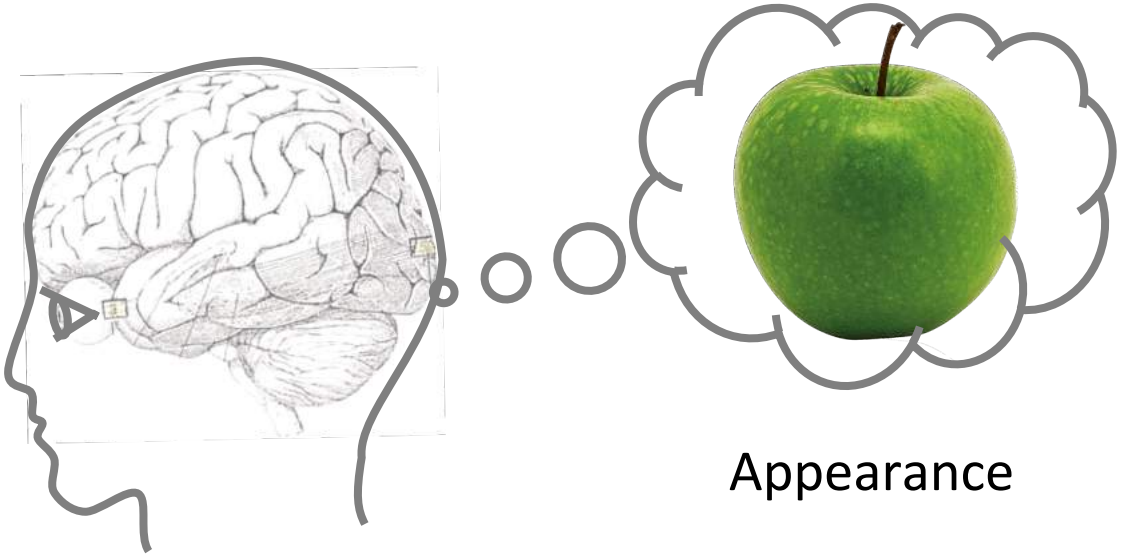


Appearance

Appearance is a visual quantity
Measurand is not accessible by direct measurement

Assessment to the measurement of appearance

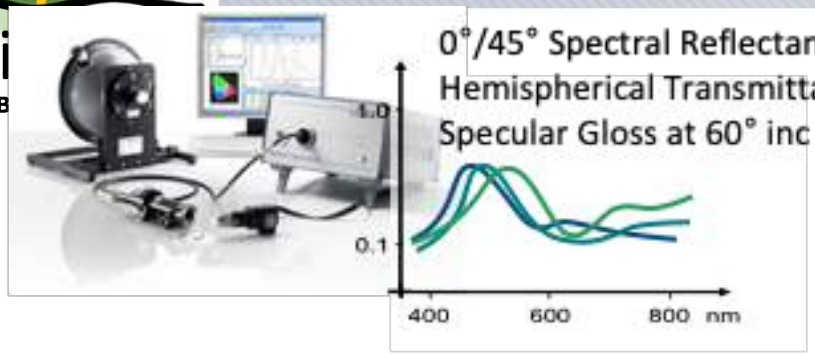
Physical Stimulus



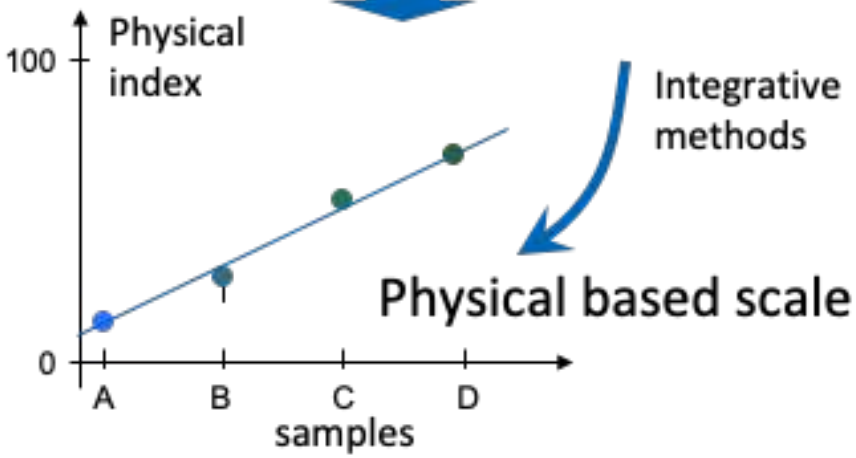
Appearance

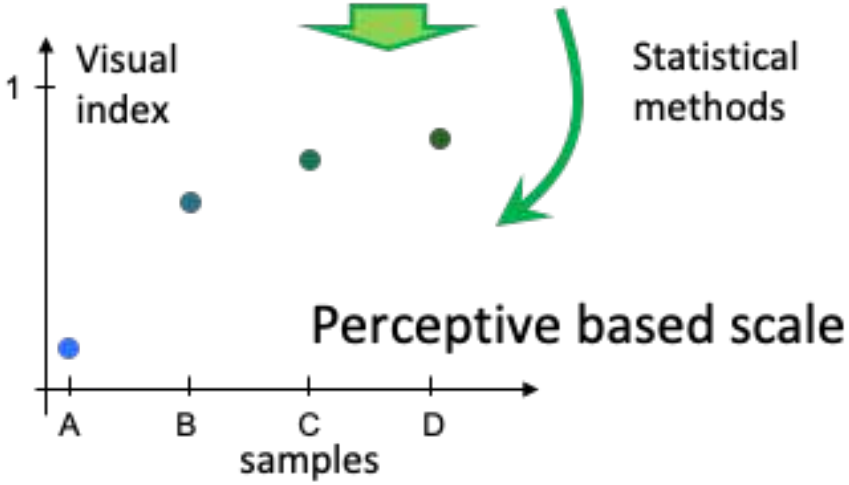
Development of samples and scales

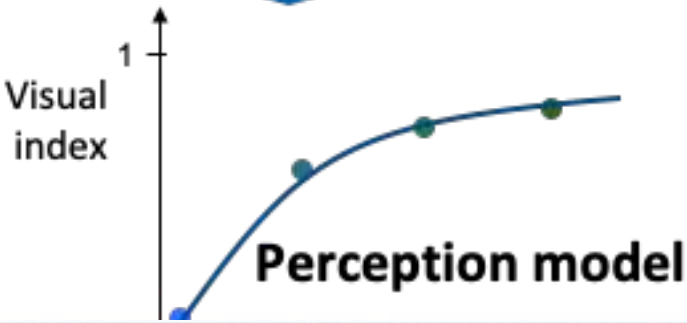
A B C D



Hue ranking
Gloss perceptive scale
Lightness difference



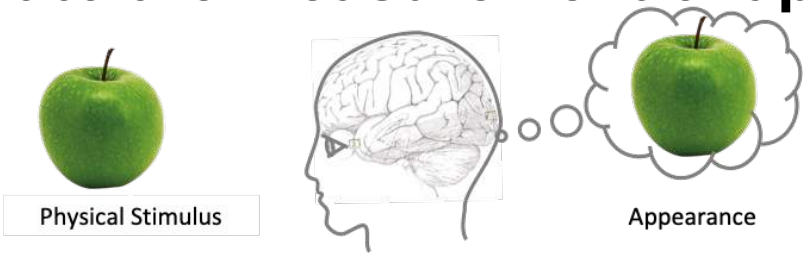


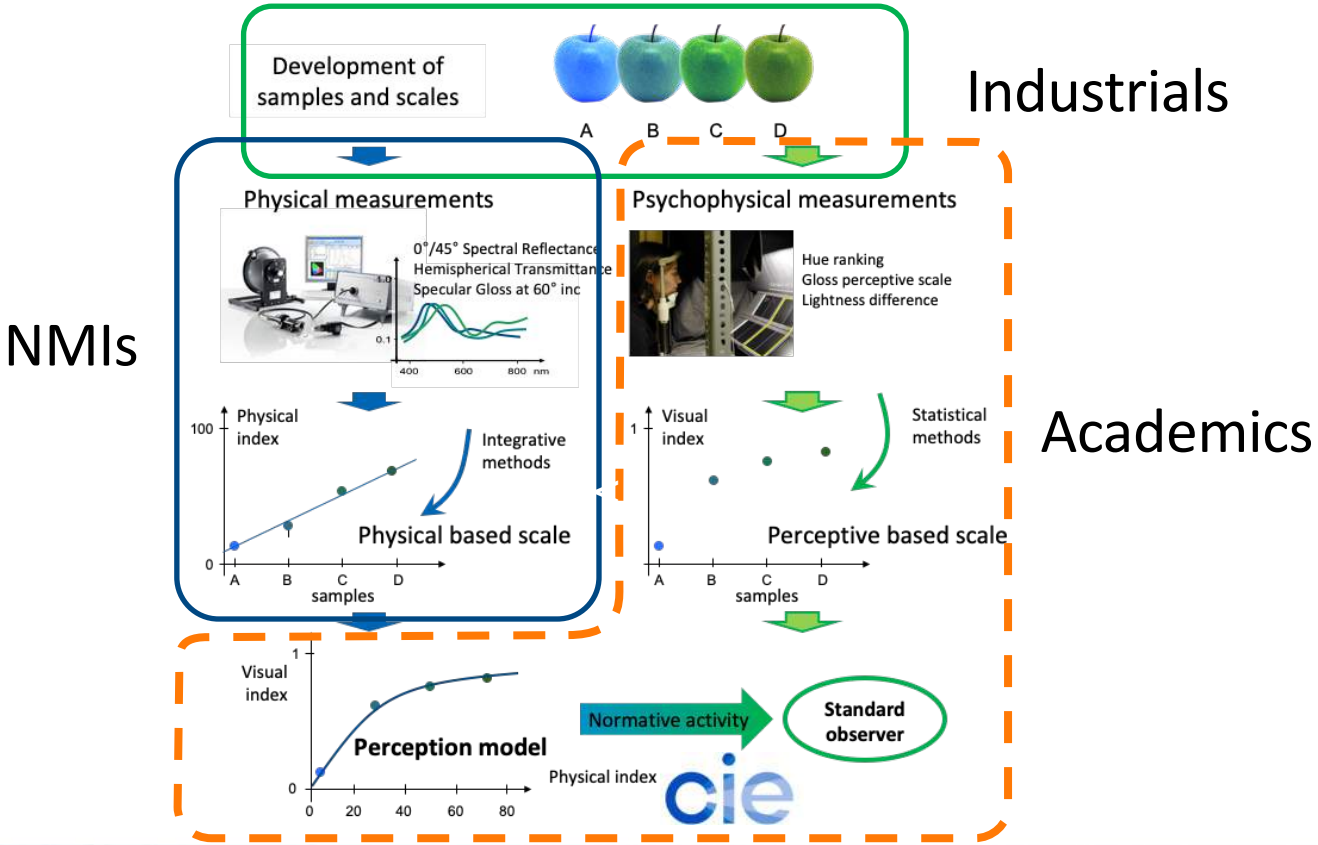


Normative activity

Standard observer

Assessment to the measurement of appearance

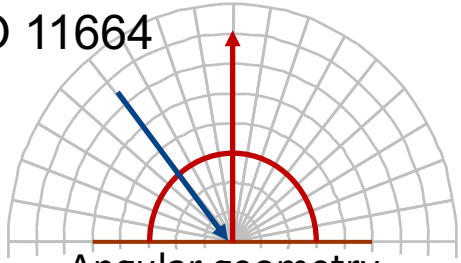




Context in 1965

Standard measurement geometries

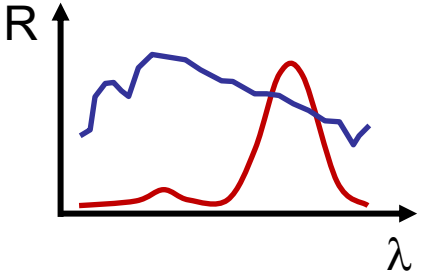
ISO 11664



Angular geometry (0/45° or 0/diff)

Portable spectrophotometer

Spectral reflectance

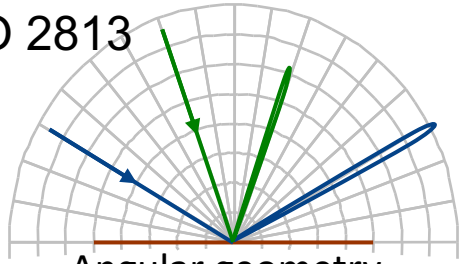


Calibration tiles

Context in 1965

Standard measurement geometries

ISO 2813



Angular geometry (60°, 20° & 85°)

Glossmeter

Gloss value

$G_{60°}$ = 98 gu

Calibration tiles

Context in 2015

Goniochromatism

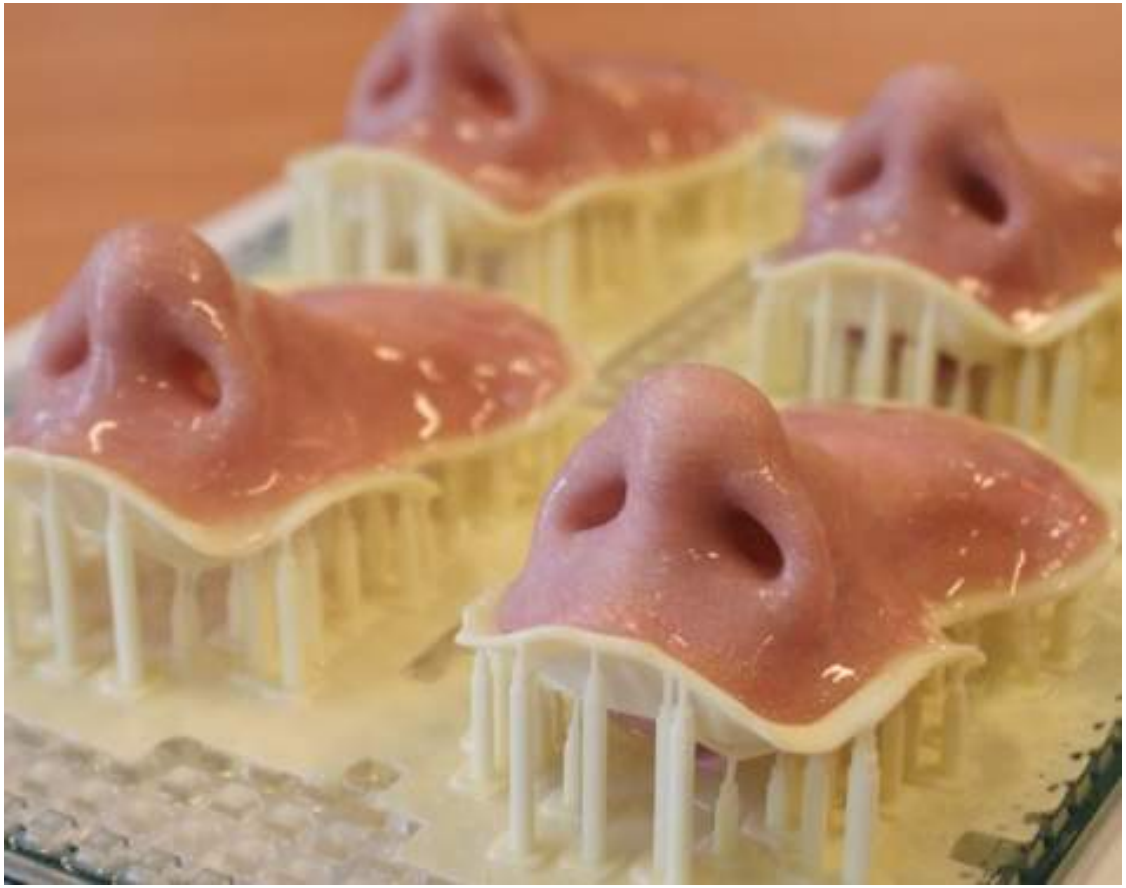
Context in 2015

Sparkle and graininess

Context in 2015

Gloss and anisotropy

Context in 2015



Translucidity in reflection and transmission

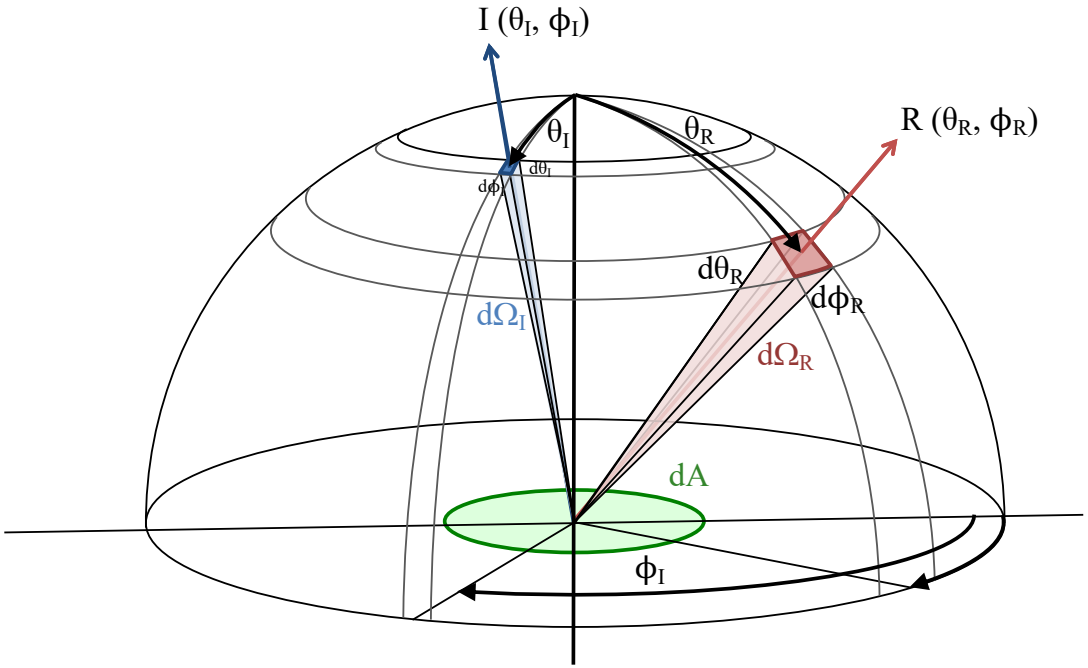
Context in 2015

Physically based virtual prototyping

Quantity

0°/45°
0°/Diff

BRDF
Bidirectional Reflectance Distribution

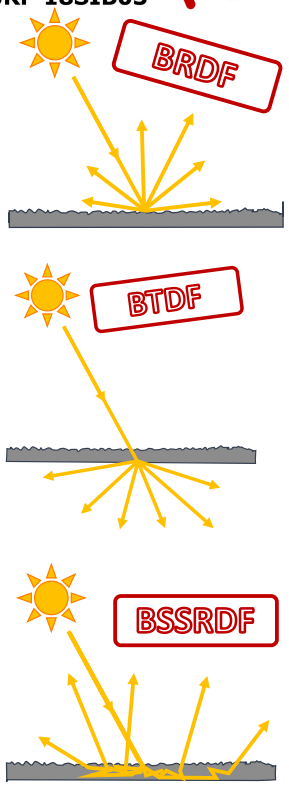


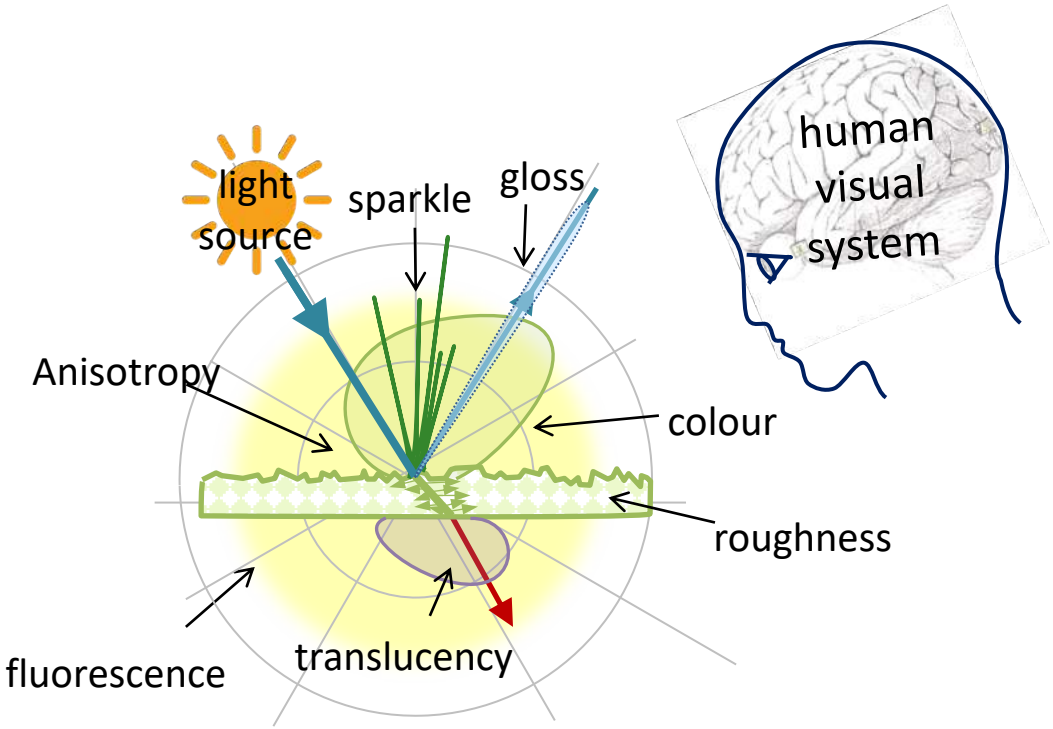
$$f(\theta_\mathbf{I}, \varphi_\mathbf{I}, \theta_\mathbf{R}, \varphi_\mathbf{R}, \Omega_\mathbf{R}, \lambda, \sigma) = \frac{\mathrm{d}L(\theta_\mathbf{I}, \varphi_\mathbf{I}, \theta_\mathbf{R}, \varphi_\mathbf{R}, \Omega_\mathbf{R}, \lambda, \sigma)}{\mathrm{d}E(\theta_\mathbf{I}, \varphi_\mathbf{I}, \lambda, \sigma)}$$

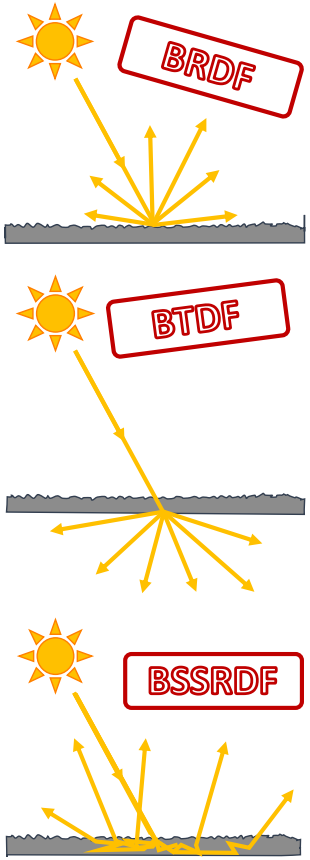
BxDiff
JRP 18SIB03

0°/45°
0°/Diff

Bidirectional Reflectance/Transmittance Distribution







BRDF – BTDF - BSSRDF

All these measurements can't be performed at the highest level with a single equipment

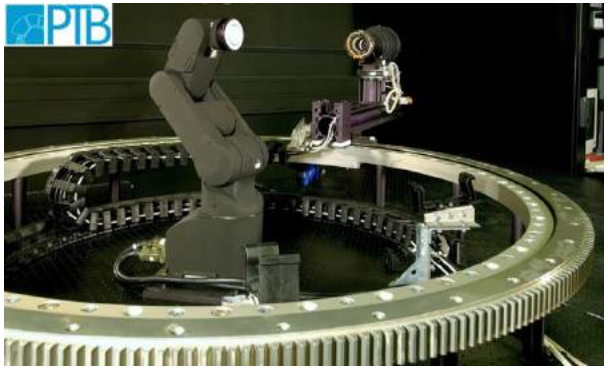
Coordinated effort at the European metrological level

The EMPIR initiative is co-funded by the European Union's Horizon 2020 research and innovation programme and the EMPIR Participating States

Ongoing coordinated action at EU level

PTB

CMI (CZ), CNAM (FR), CSIC (ES), INRIM (IT), Aalto (FI), MSL (NZ), PTB x2 (GE), METAS (CH), CMI (CZ)



JRP – IND 52 xReflect

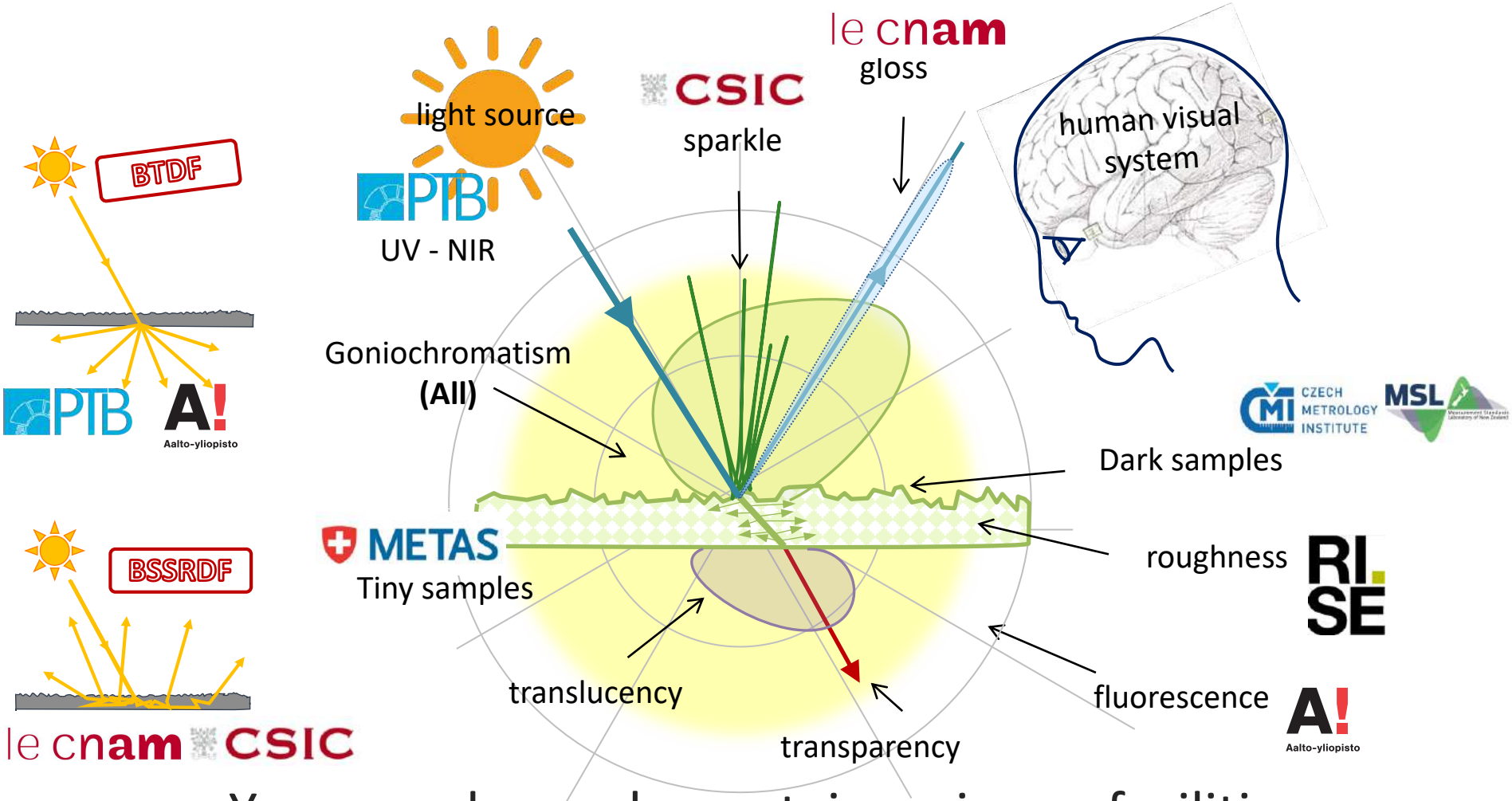
BiRD
Bidirectional Reflectance Defi
JRP 16NRM08

BxDiff
JRP 18SIB03

2005 2013 2016 2017 2019 2020 2022

BxDiff
JRP 18SIB03

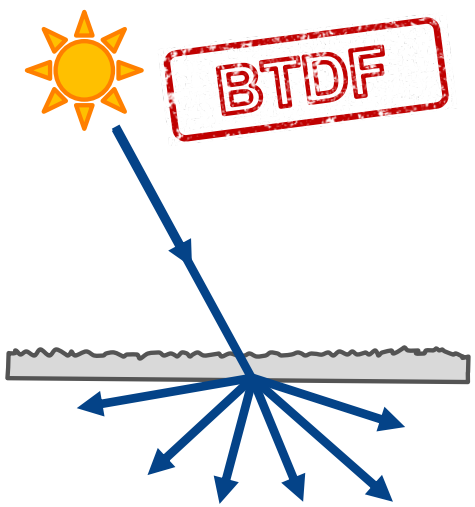
Ongoing coordinated action at EU level



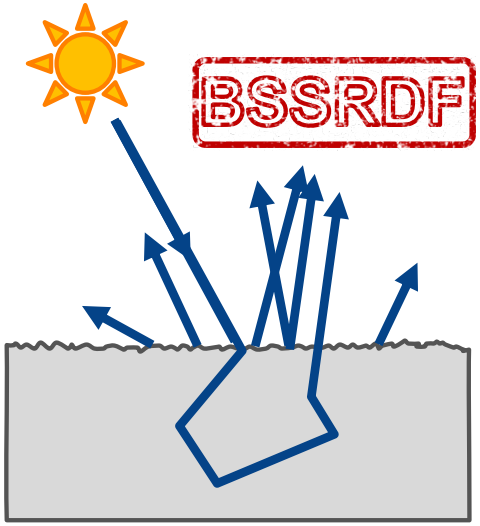
Young and complementaire primary facilities

Proposal

1. Developing primary reference facilities and standard artefacts for the measurement and the dissemination of the Bidirectional Transmittance Distribution Functions (BTDF) as a traceable quantity,
2. Developing primary reference facilities and standard artefacts for the measurement and the dissemination of the Bidirectional Scattering Surface Reflectance Distribution Function (BSSRDF) as a traceable quantity



$f\,(\theta_{\mathrm{I}}\,\varphi_{\mathrm{I}}\,\theta_{\mathrm{T}}\,\varphi_{\mathrm{T}}\,\lambda\,\sigma)$



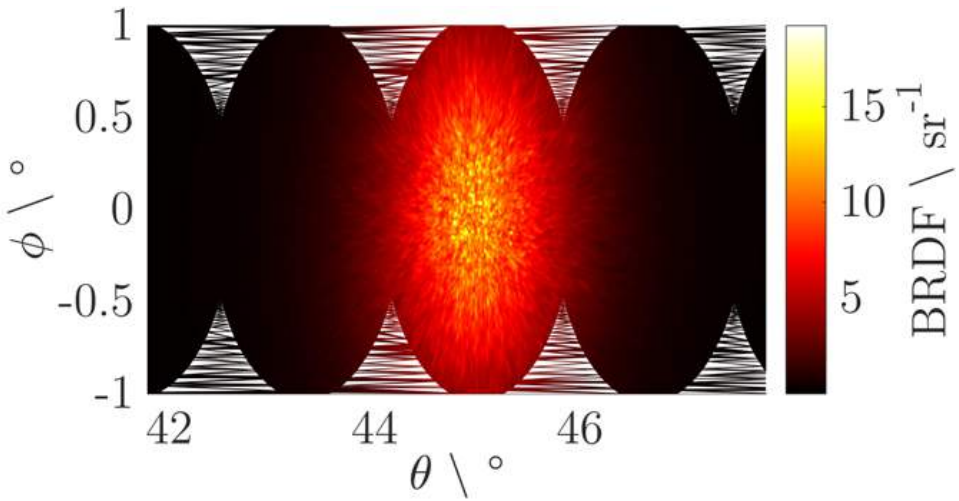
$f(\theta_{\mathrm{I}}\,\varphi_{\mathrm{I}}\,\theta_{\mathrm{T}}\,\varphi_{\mathrm{T}}\,x_I y_I x_R y_R \lambda\,\sigma)$

Proposal

3. Addressing advanced metrological issues related to Bidirectional Reflectance Distribution Function (BRDF) measurement, including polarization, angles control and speckle induced effects in order to reduce by a factor 2 the measurement uncertainty at the highest level

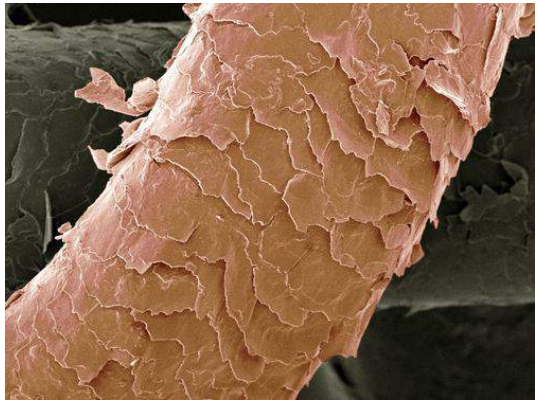
Polarisation

Speckle



Proposal

4. Establishing a full metrological traceability of the BRDF from tiny objects (micrometric scale) to regular objects (centimetric scale),



5. Engaging with industry, academics and end-users know-how transfer, measurement techniques and reference materials issued from the project, in order to strengthen the level of traceability in the field of spectrophotometry, thus allowing a better control of the appearance of manufactured objects.

Consortium

9 national metrological institutes

3 academics

5 industrials

Budget : 1.6 M€

Stakeholders

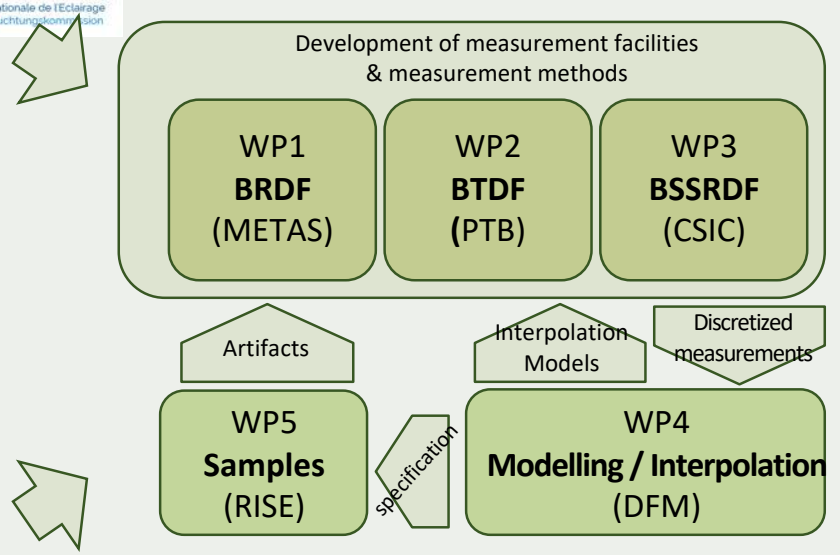
Made by Munksjö
Audi
Bogense Plast as
cie
dfwg
www.dfwg.de
DM&S
ELDIM
AUTODESK.
L'ORÉAL
MERCK
elcometer
inspection equipment
MICROBEADS
SCHLENK
KONICA MINOLTA
Instrument Systems
KONICA MINOLTA Group
seelab
the color guarantee
x-rite
right on color
NEXT LIMIT
BASF
The Chemical Company
TOYOTA

Structure

Implementation

Strong interaction with global standard organisation
Inputs in TC2-85 (BRDF), JTC12 (Sparkle)
JTC16 (Gloss), DR2-79 (Transmittance)

Fresh scientific heritage from **JRP xDReflect** and **JRP BiRD**



Collaboration with manufacturers of multiangle spectrophotometers and goniospectrophotometers representing more than 95% of market