

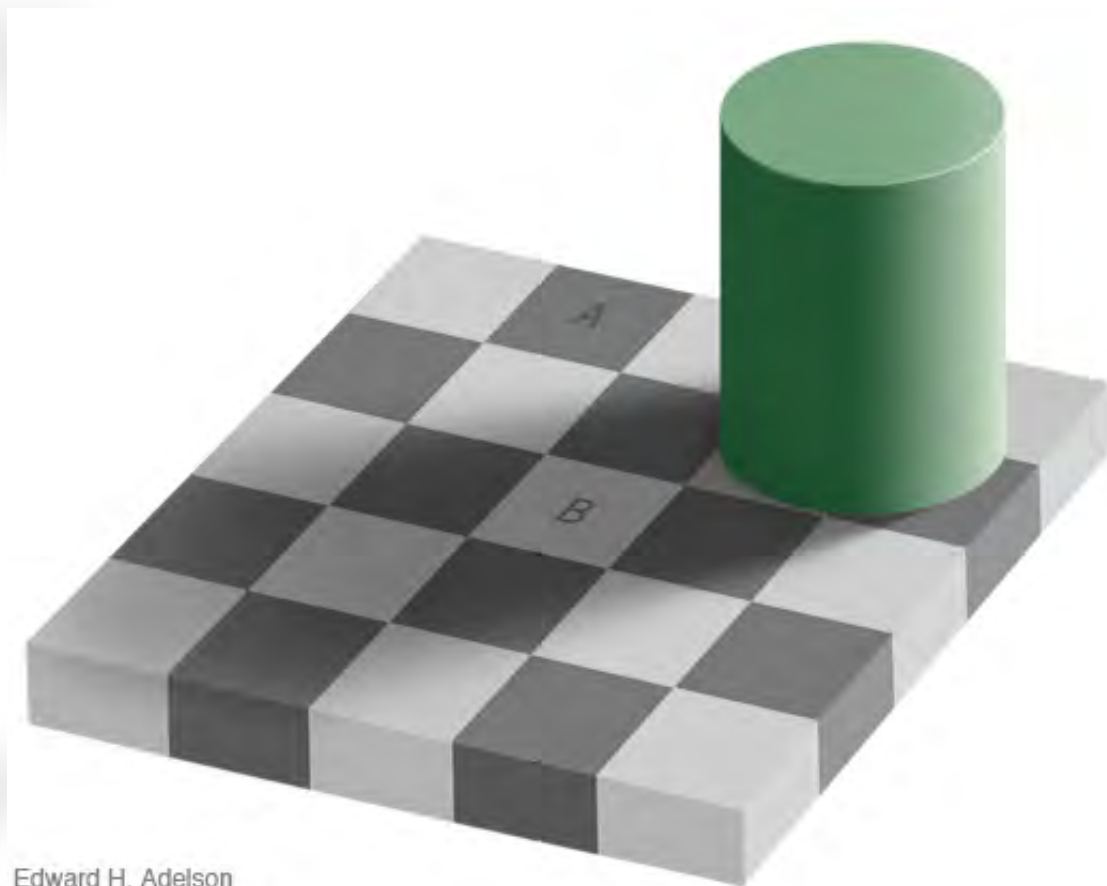


# WP 5 Visual perception

# WP5 overview

The aim of WP 5 is to measure the visual attributes of materials through subjective responses, providing a connection between visual appearance evaluation and material metrological characterization

# Physical Photometry Breakdown



Edward H. Adelson

Physical Photometry

# Physical Colorimetry Breakdown

R=255  
G=255  
B= 0

R=255  
G=255  
B= 0



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# WP 5 Objectives

- To provide a synthesis between subjective visual attributes and quantitative physical parameters
  - Known Gloss artefacts, Goniochromatic samples from WP I
- To highlight metrological and uncertainty requirements;
  - Sensitivity of perceived attributes vs measured values – uncert – tolleranc
- To realize reference systems for comparison and industrial testing;
  - Viewing cabinet; ad hoc observation boxes
- To correlate visual intensity response stimuli to material characteristics and environment attributes
  - Tested geometrical, spectral, adaptation influences

# WP5 tasks

- Task 1:
  - Definition of artefacts to test – strong correlation WP1 and WP2
- Task 2
  - Visual attributes for **gloss**
- Task 3
  - Visual attributes for **colour** and **sparkle/graininess**
- Task 4
  - Influences of **spectral** environment on the perception
- Task 5
  - Influences of environment **geometry** on the perception
- Task 6
  - Procedures and guidelines



# Task 6: Procedures and guidelines

## Guidelines for:

- Methods for visual evaluation INRIM + UA
- Lighting arrangements INRIM
- Viewing cabinet for Sparkle and Graininess evaluation UA
- Influence of particle size UA
- New standard test method for gloss CNAM



# Influences of LED on perception

INRIM

P. Iacomussi, M. Radis, G. Rossi







Compare appearance evaluations with measured quantities usually associated with the appearance

- **DIFFERENT MATERIALS CHARACTERISTICS**
  - Goniochromatic materials set WP1, solid colours
- **DIFFERENT GEOMETRIES (45/0 45/30 45/open, d/open)**
- **DIFFERENT LIGHT SOURCES (LED, N-LED)**
- **DIFFERENT CCT 2700, 4000, 6500**

➤ **Measured vs Perceived**

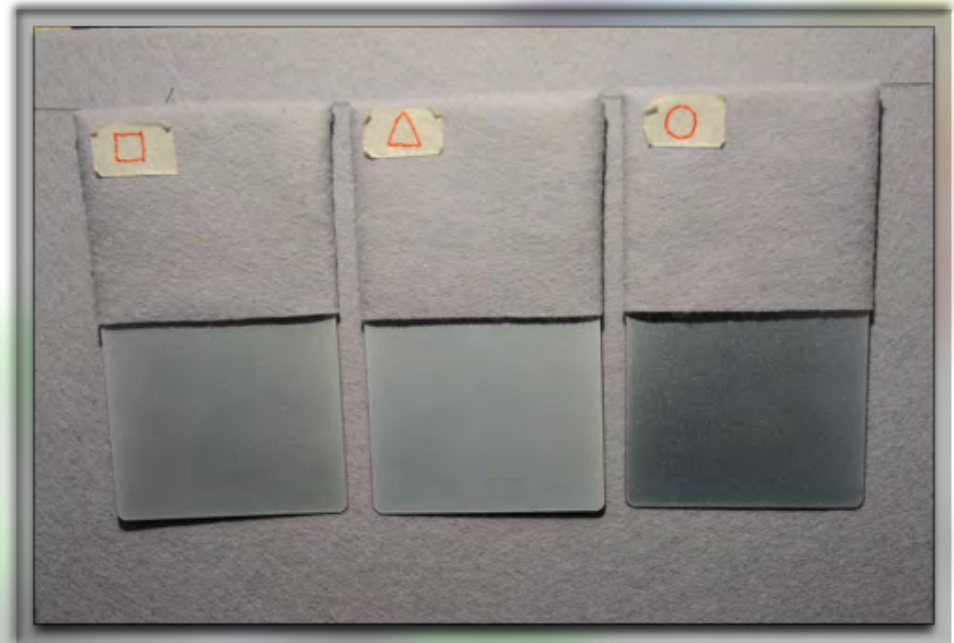
- **Lightness vs Brightness**
- **Sparkle vs Sparkling**
- **Graininess**
- **Gloss vs Glossiness**
- **Chroma vs Saturation**

# Subjective test

To provide a ranking  
by perceived  
quantities

Identifying  
samples by  
symbols

194 subjects



# Subjective Test

## Test 1

To provide a ranking by

- SPARKLING
- BRIGHTNESS

16 Samples (6 set)

108 Subjects

Conditions

- 45/0
- 45/20
- 45/30
- 45/Open

$E_m$  500 lx

## Test 2

To provide a ranking by

- GLOSS
- SATURATION

21 Samples

58 Subjects

Conditions

- 45/0
- 45/30
- 45/Open

$E_m$  80 lx

## Test 3

To provide a ranking by

- GRAININESS
- BRIGHTNESS

10 Samples

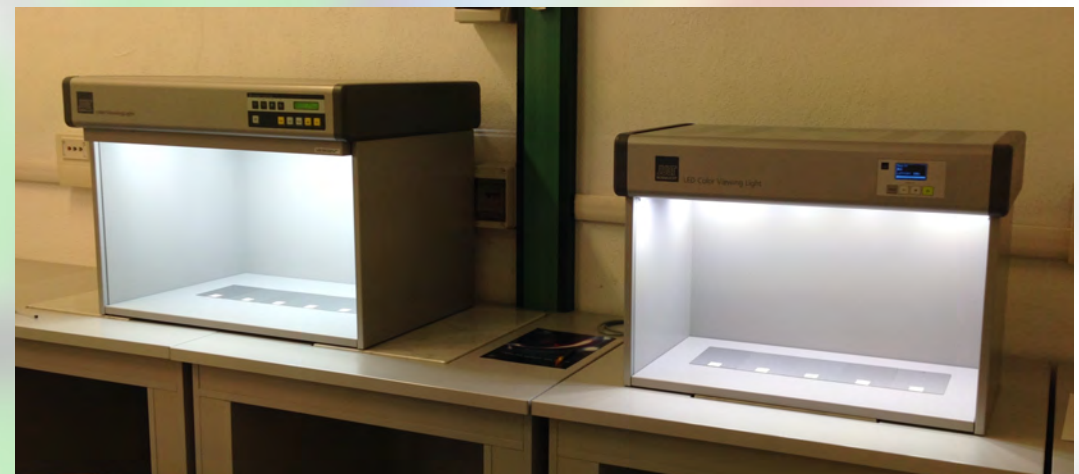
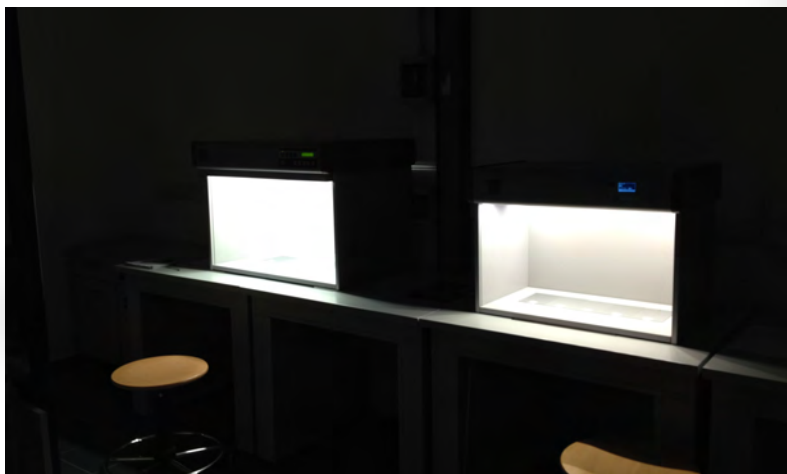
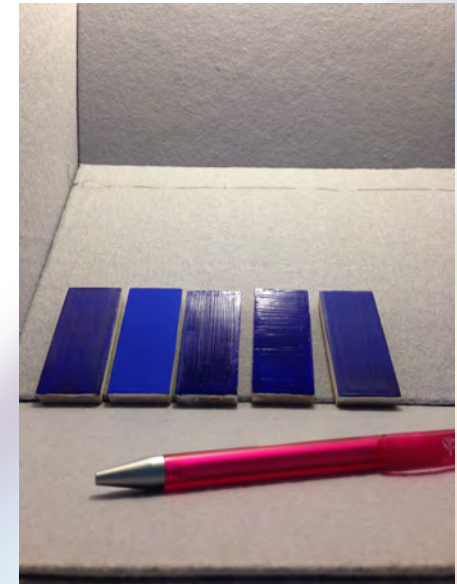
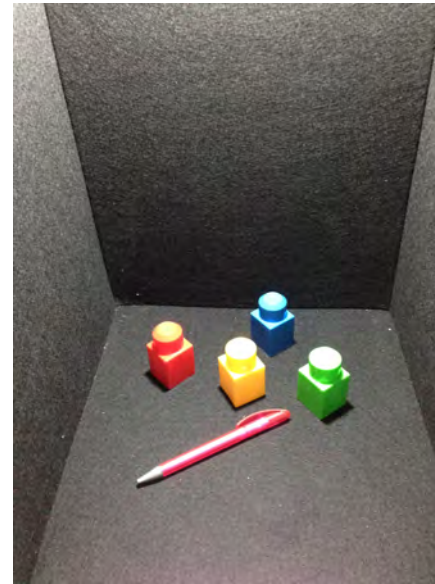
28 Subjects

Conditions

- d/Open

$E_m$  1590 lx





IND 52 xDRreflect Final meeting Torino 21-23 June

# Subjective test I - Quantities

- Perceived quantities:

- Brightness

- Sparkling

- Measured quantities:
- Spectral Reflectance (goniometer / portable)
- Luminance
- Lightness  $L^*a^*b^*$
- Sparkle area, Sparkle Intensity



# Samples WP1

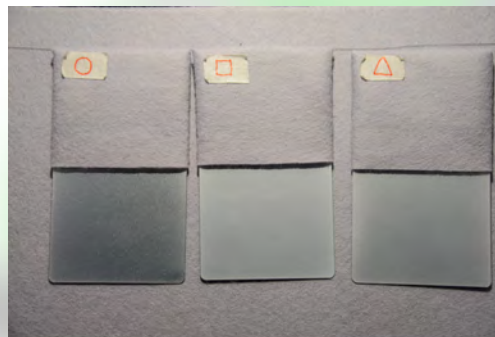
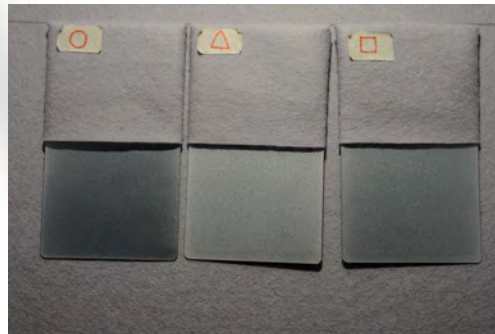
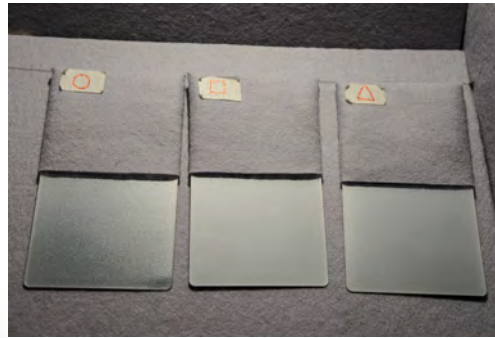
## Iridion SET Ia

Mica particles & Rutile

1A: 10 – 60  $\mu\text{m}$

2A: < 15  $\mu\text{m}$

3A: 5 – 25  $\mu\text{m}$



## TEST I

### STAPA SET Sa

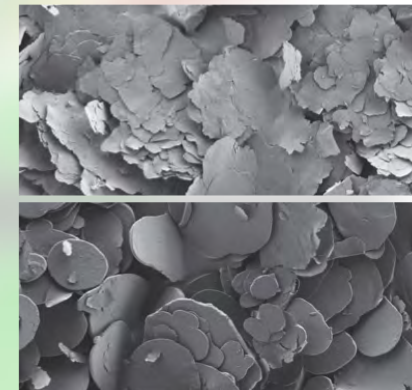
Aluminium & Silica

Layer

2A: < 15  $\mu\text{m}$

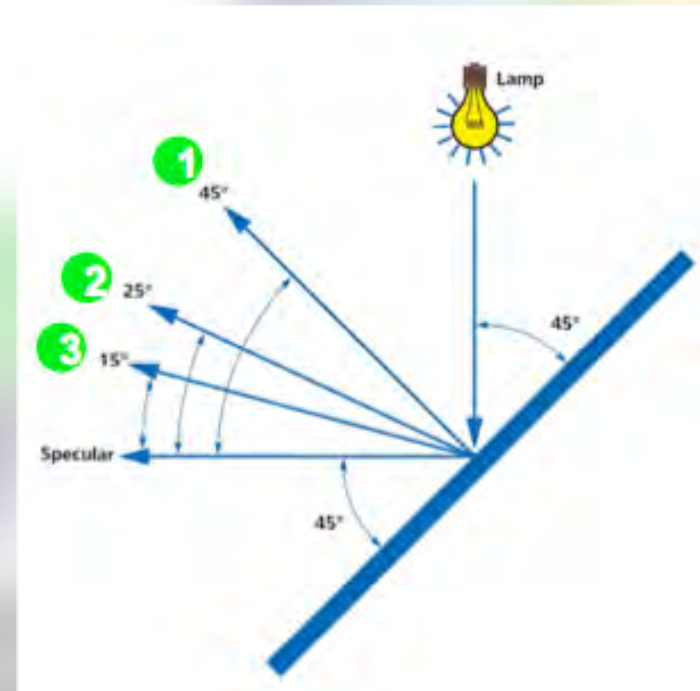
5A: Silver Dollar 10  
- 30  $\mu\text{m}$

6A: Corn flakes 10 -  
30  $\mu\text{m}$



# Subjective test - Conditions of Observation

- ☐ Same conditions as portable measuring devices
  - ☐ 45/0 (45/45)
  - ☐ 45/20 (45/25)
  - ☐ 45/30 (45/15)
- ☐ Free observation



# Subjective test - Conditions of Observation

- Same conditions as portable measuring devices
  - 45/0 (45/45)
  - 45/20 (45/25)
  - 45/30 (45/15)
- Free observation

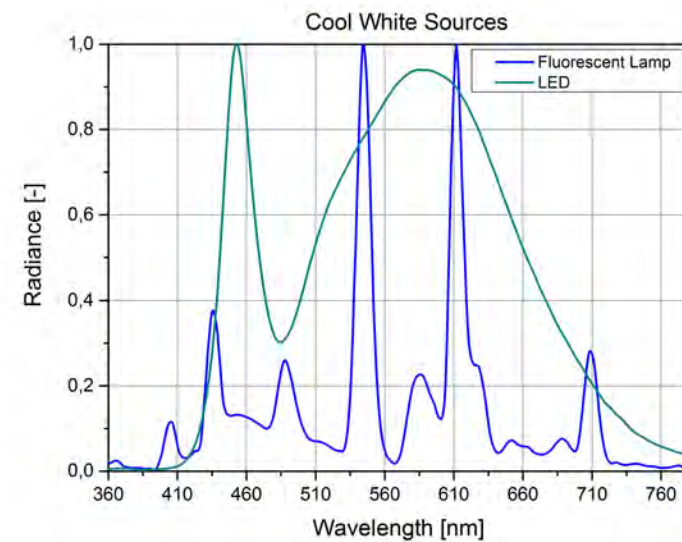
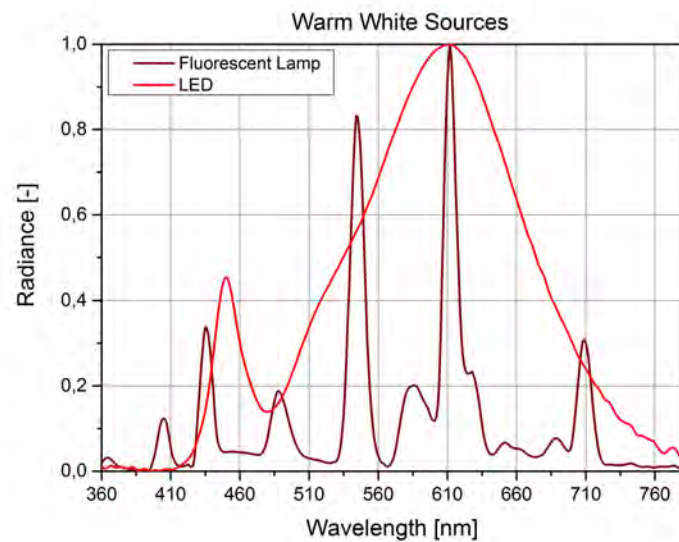


# Subjective test - Lighting sources

## ☐ LED and FLUORESCENT LIGHTS

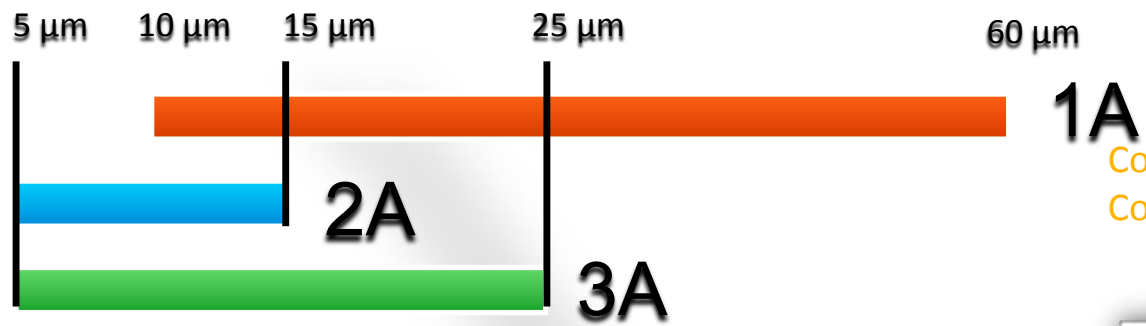
☐ Same CCT

☐ Different CRI



# LIGHTNESS vs BRIGHTNESS

45°/0° condition



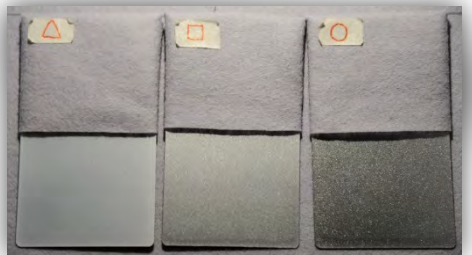
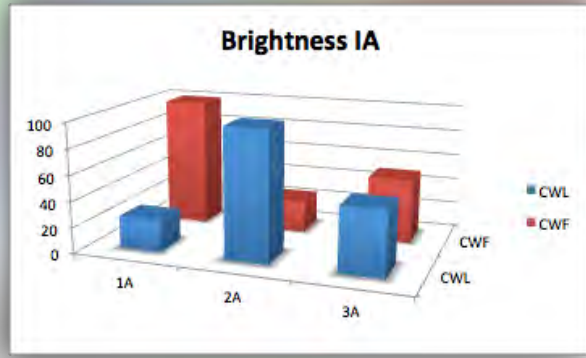
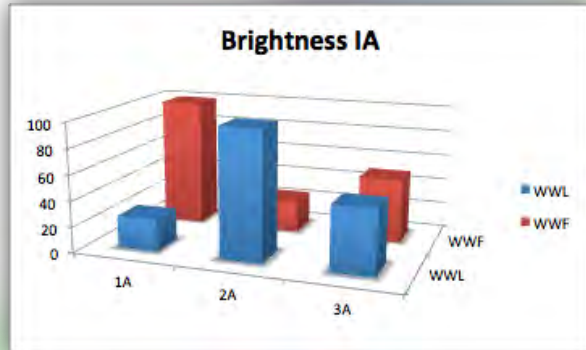
Cold/Warm White LED (CWL/WWL)  
Cold/Warm White Fluo (CWF/WWF)

MEASURED

Lightness,  $L^*$      $1A < 2A < 3A$

PERCEIVED

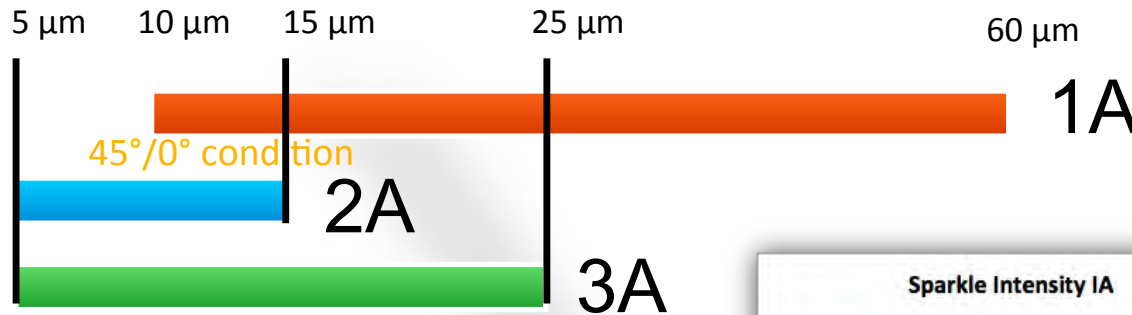
Brightness  
 $1A < 3A < 2A$  LED  
 $2A < 3A < 1A$  FLUO





# SPARKLE vs SPARKLING

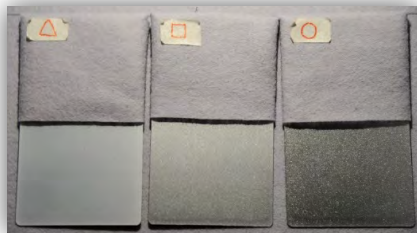
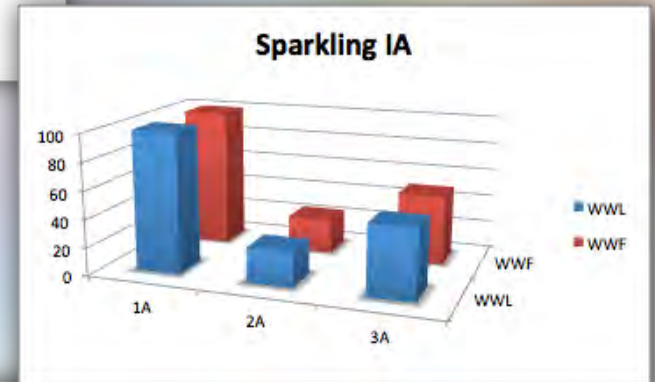
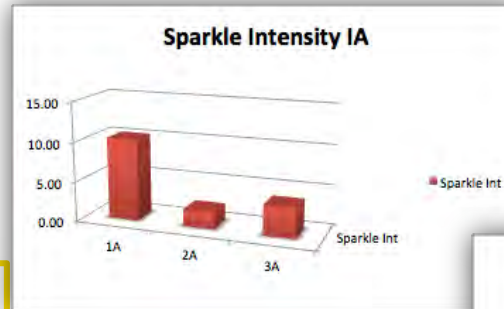
45°/0° condition



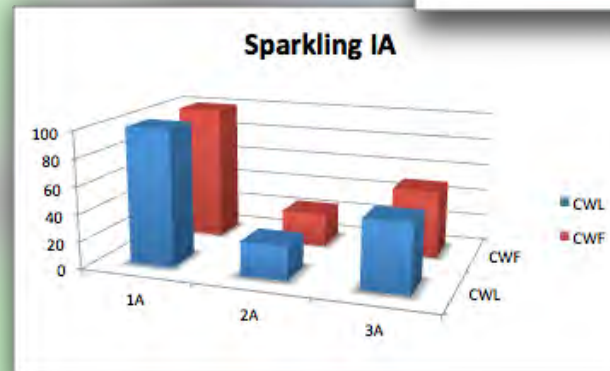
Cold/Warm White LED (CWL/WWL)  
Cold/Warm White Fluo (CWF/WWF)

MEASURED

SPARKLE 2A < 3A < 1A



SPARKLING  
2A < 3A < 1A FLUO  
2A < 3A < 1A LED



PERCEIVED

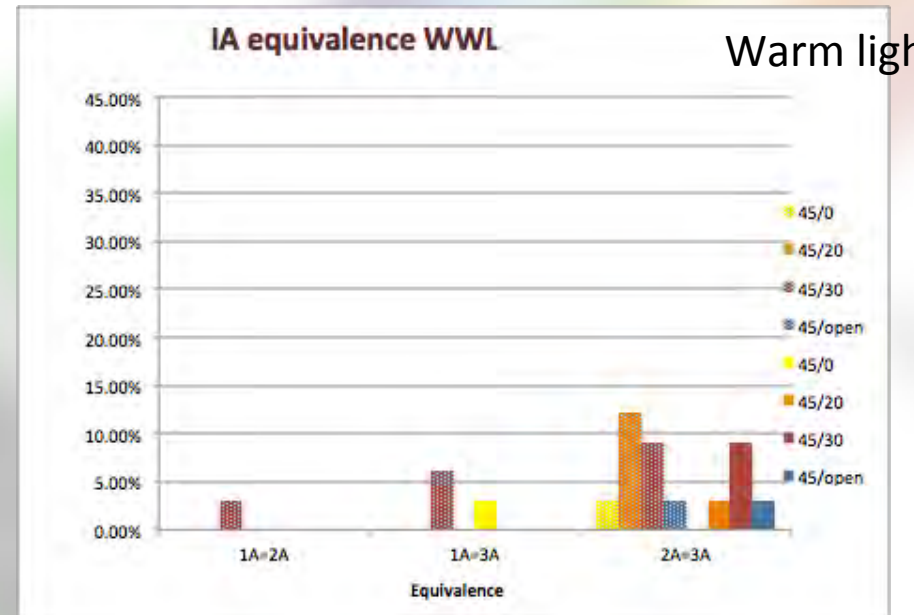
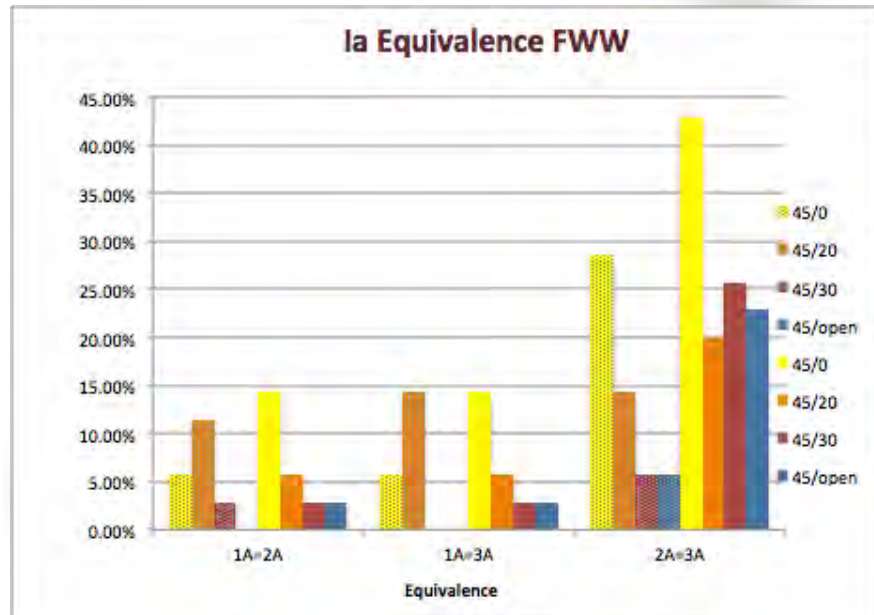
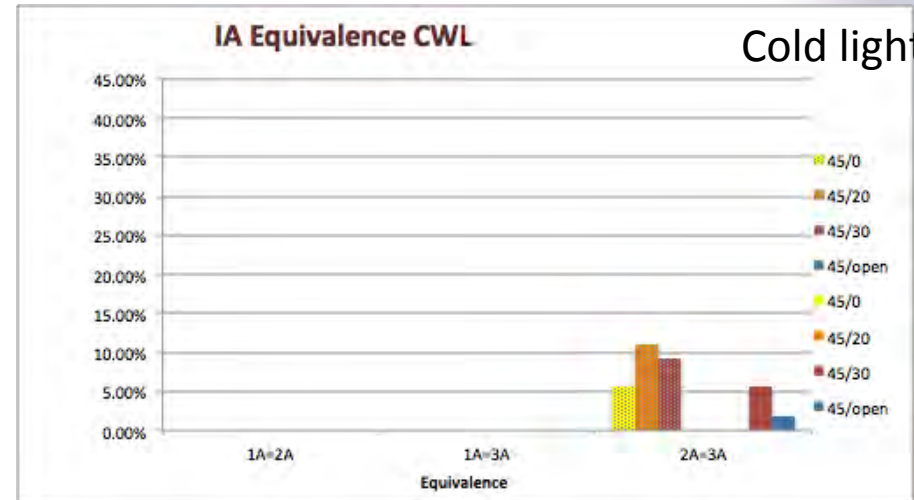
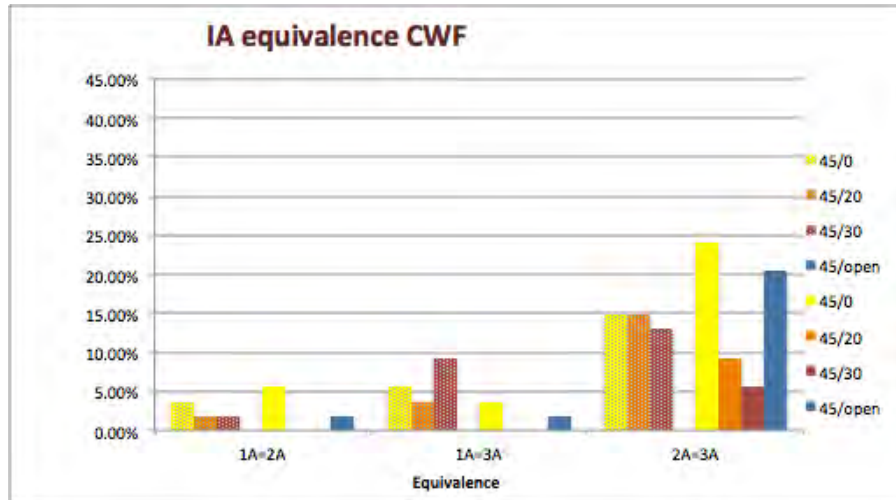


# MEASURED vs PERCEIVED

Set	Ranking from higher to lower by perceived values 45/0							
	Brightness				Sparkle			
	LCW	FCW	LWW	FWW	LCW	FCW	LWW	FWW
Ia	2A 3A 1A	1A 3A 2A	2A 3A 1A	1A 3A 2A	1A 3A 2A	1A 3A 2A	1A 3A 2A	1A 3A 2A
Sa	2A 6A 5A	5A 6A 2A	2A 6A 5A	5A 6A 2A	5A 6A 2A	5A 6A 2A	5A 6A 2A	5A 6A 2A

45°/0° sparkle measurement is within tested geometries

# Perceived values Set IA equivalence

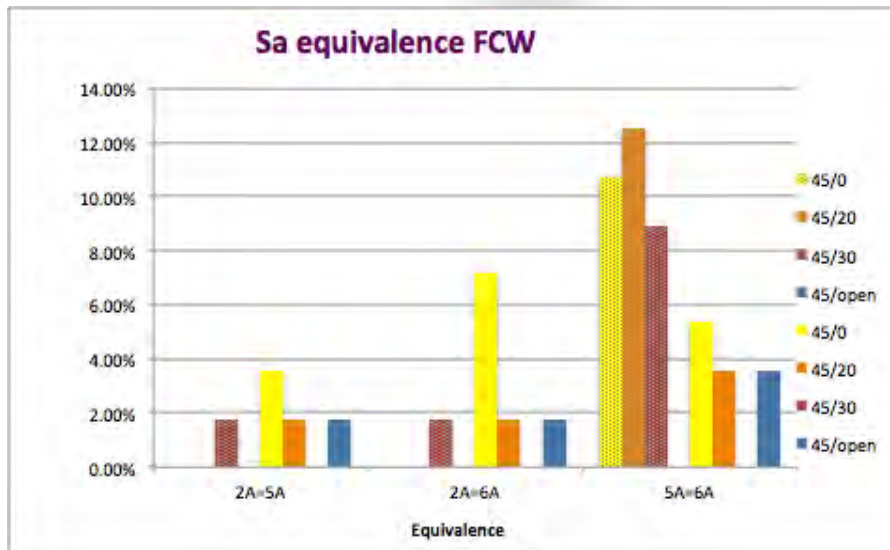


Dotted equivalence in brightness  
none in sparkle

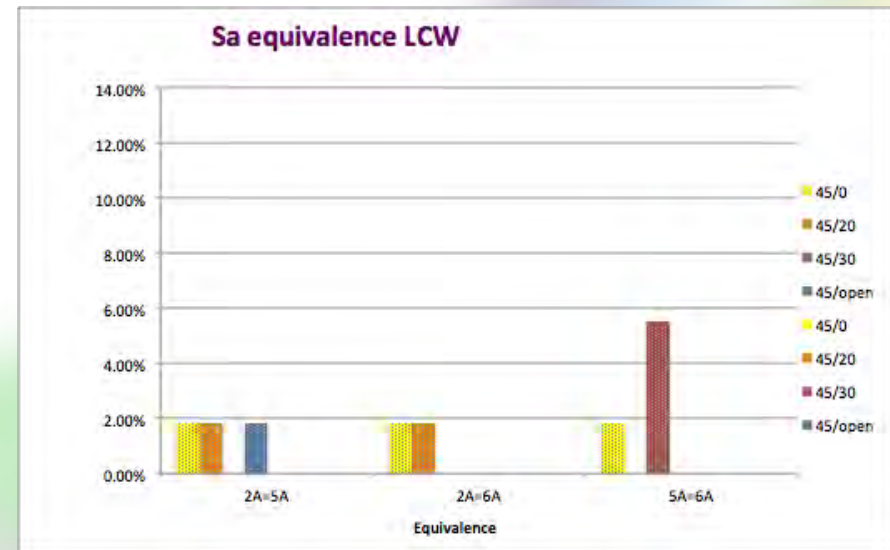
Solid equivalence in sparkle few only in brightness, quite

# Perceived values Set SA - equivalence

Cold lights



FLUO Lighting



LED Lighting

Dotted equivalence in brightness  
Solid equivalence in sparkle

# Subjective test 3 - Quantities

- Perceived quantities:

- Graininess

- Brightness

## Measured quantities:

- Spectral Reflectance (goniometer)

- Graininess

- Lightness CIE  $L^*a^*b^*$

# Samples WP1

## STAPA SET 3

Aluminium & Silica Layer

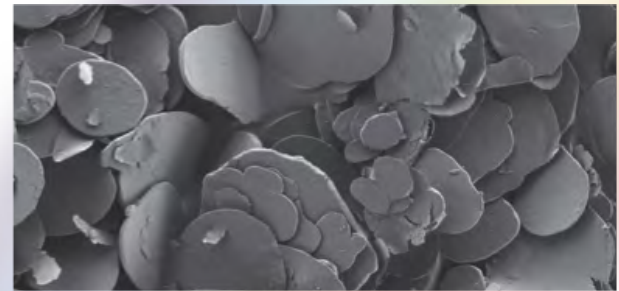
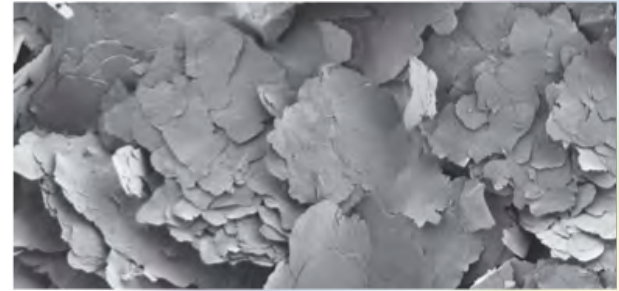
Corn flakes & silver dollar

Set1 Corn Flakes

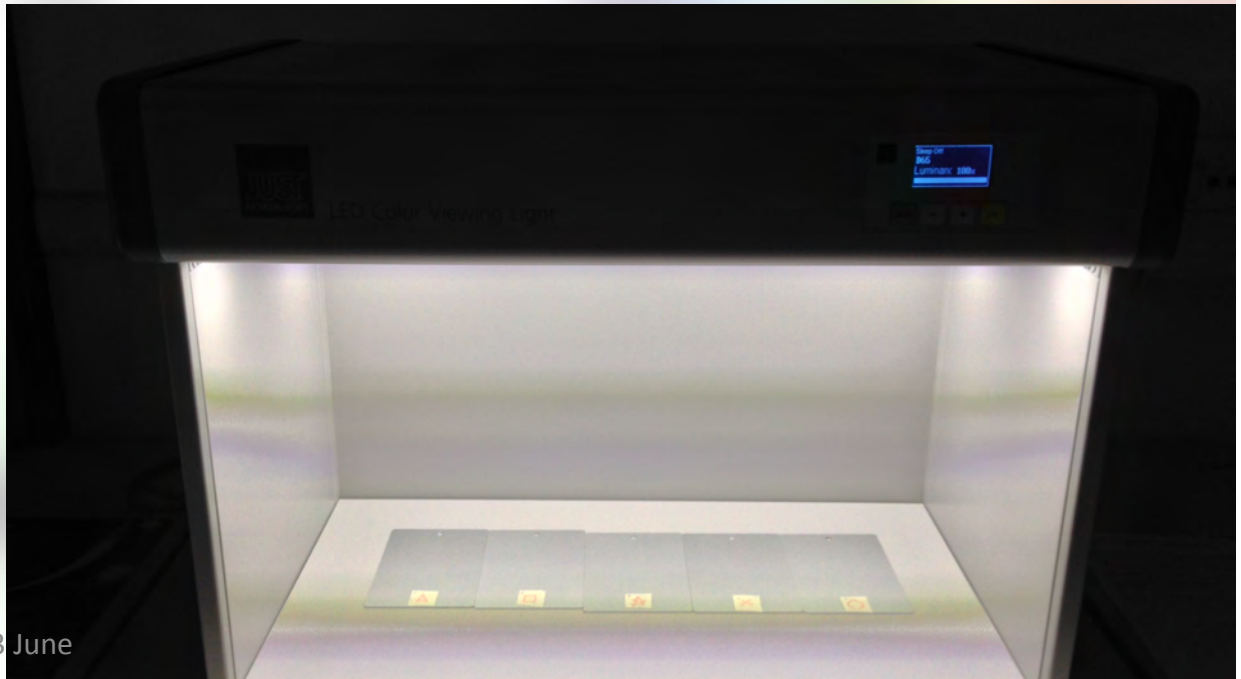
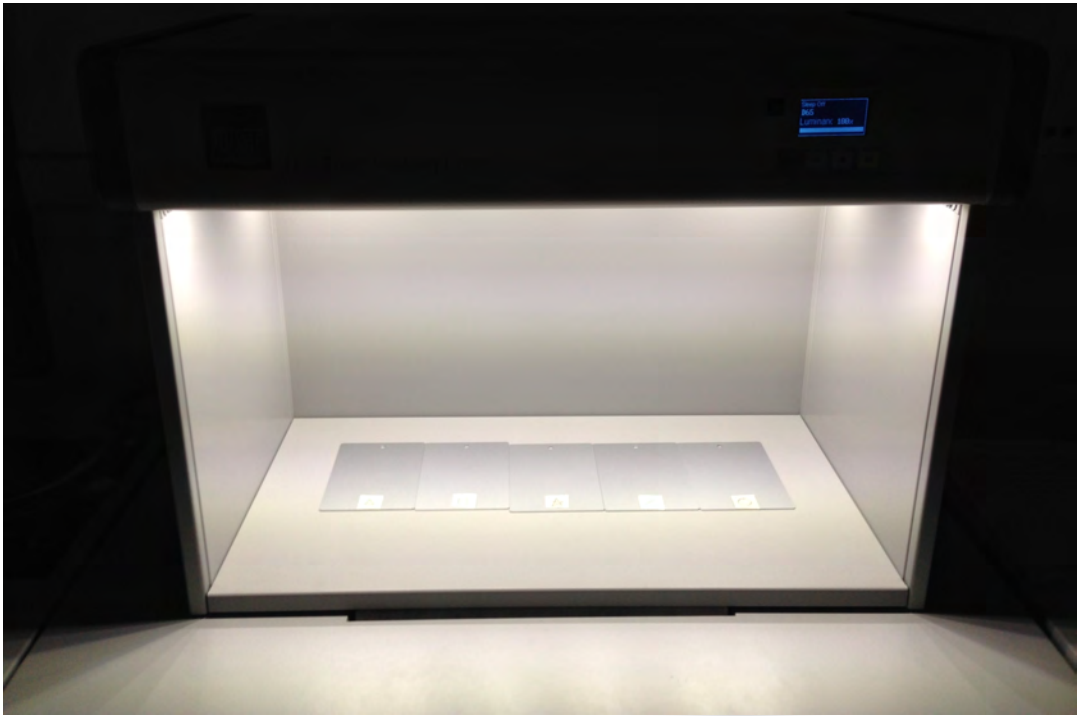
Set2 Silver dollar

Set3 Corn flakes vs Silver dollar  
with the same particle distribution

## TEST 3





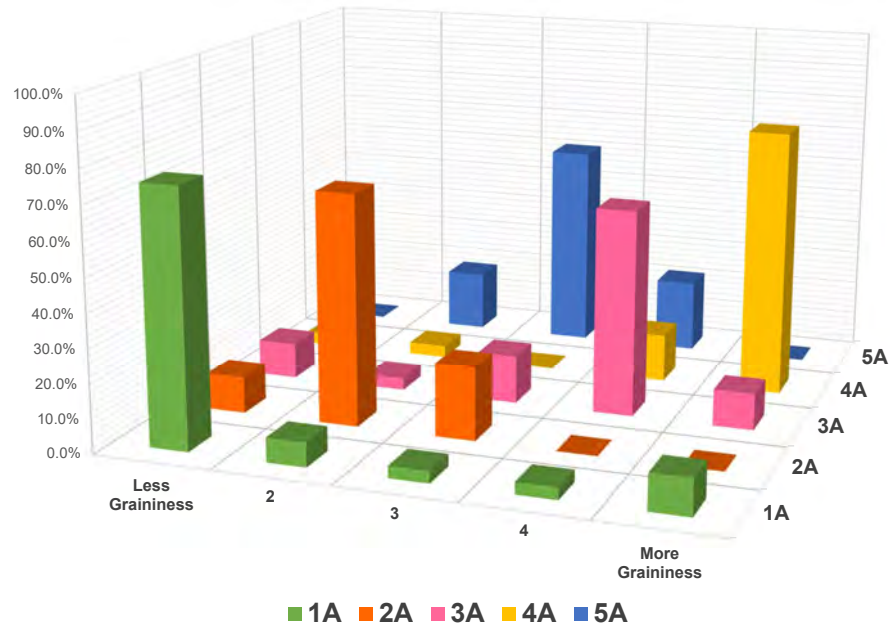


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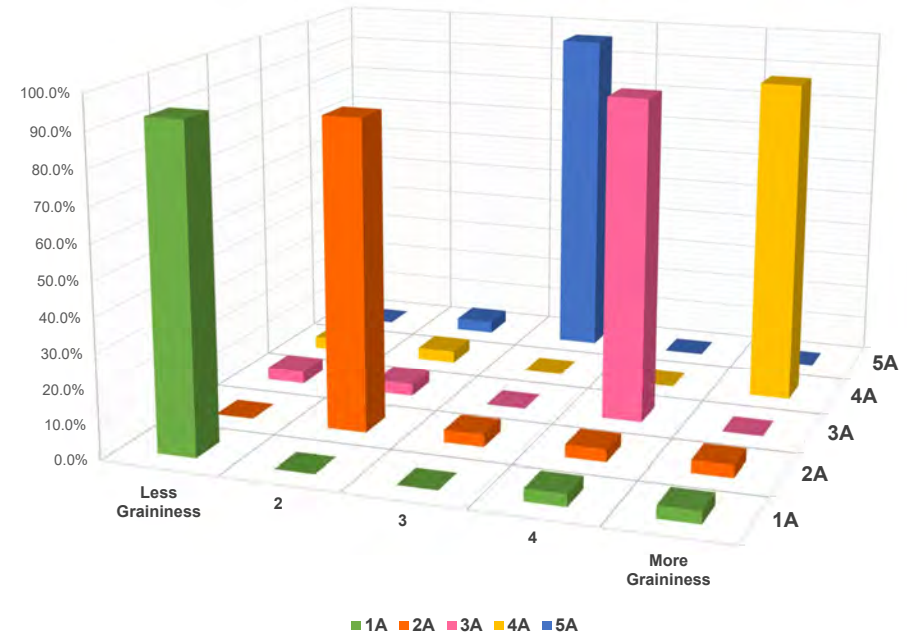


# Graininess

Graininess SET 1 - Fluorescent Lamp



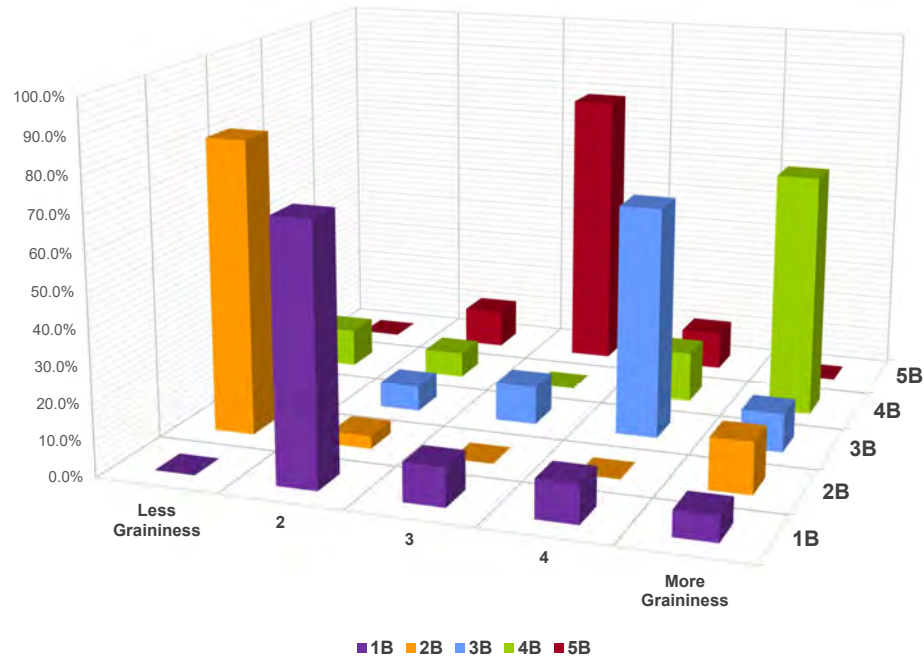
Graininess SET 1 - LED



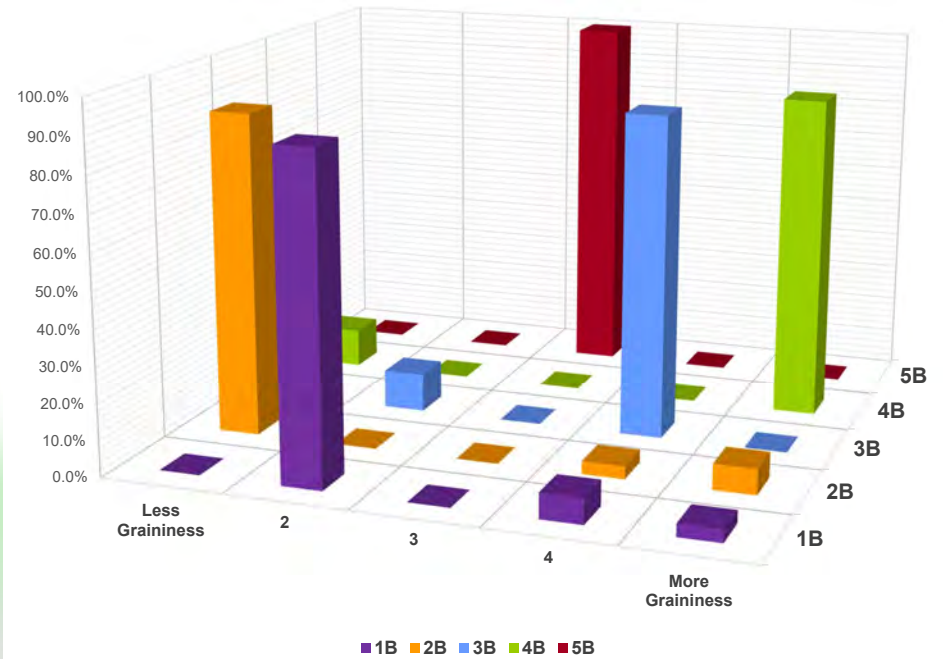
Corn flakes

# Graininess

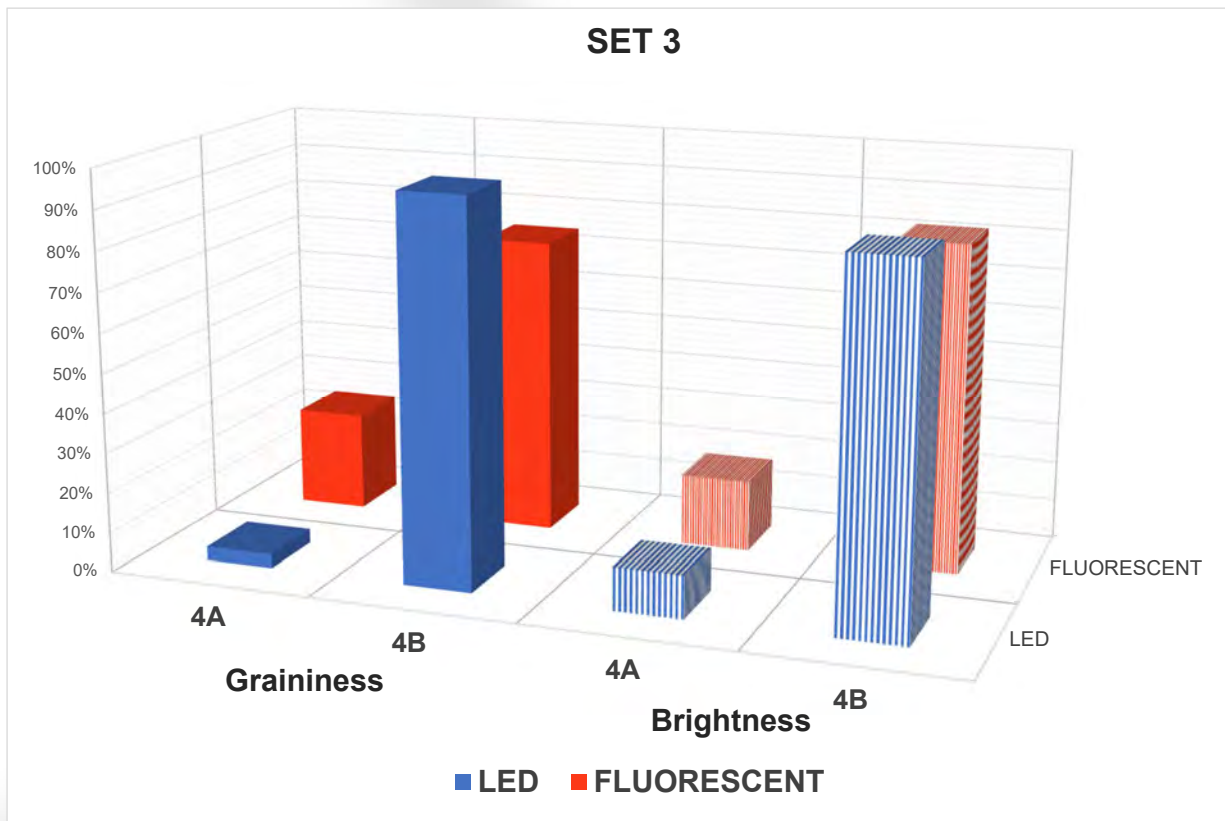
Graininess SET 2 - Fluorescent Lamp



Graininess SET 2 - LED



Silver dollar



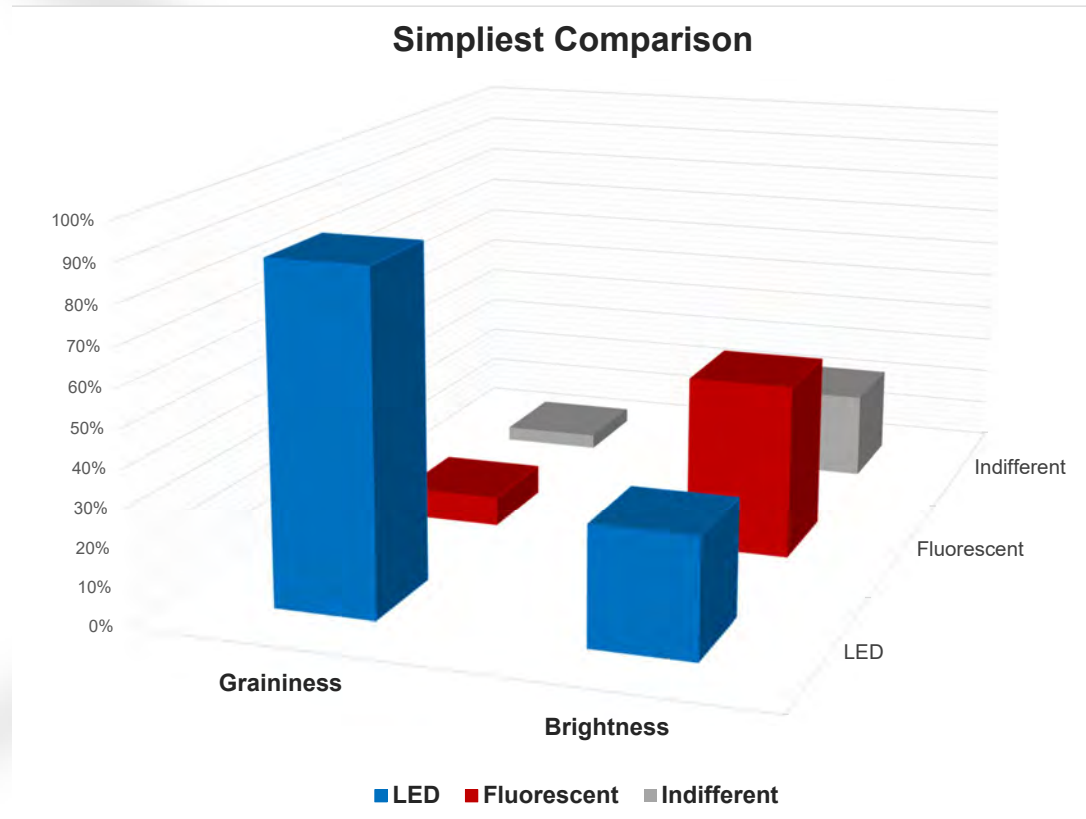
4 A: 18 35 55  $\mu\text{m}$

Corn  
5,47 graininess

4 B: 18 34 53  $\mu\text{m}$

Silver  
7,17 graininess

# Easier to make comparison



# Subjective test 2 - Quantities

- Perceived quantities:

- Gloss

- Saturation

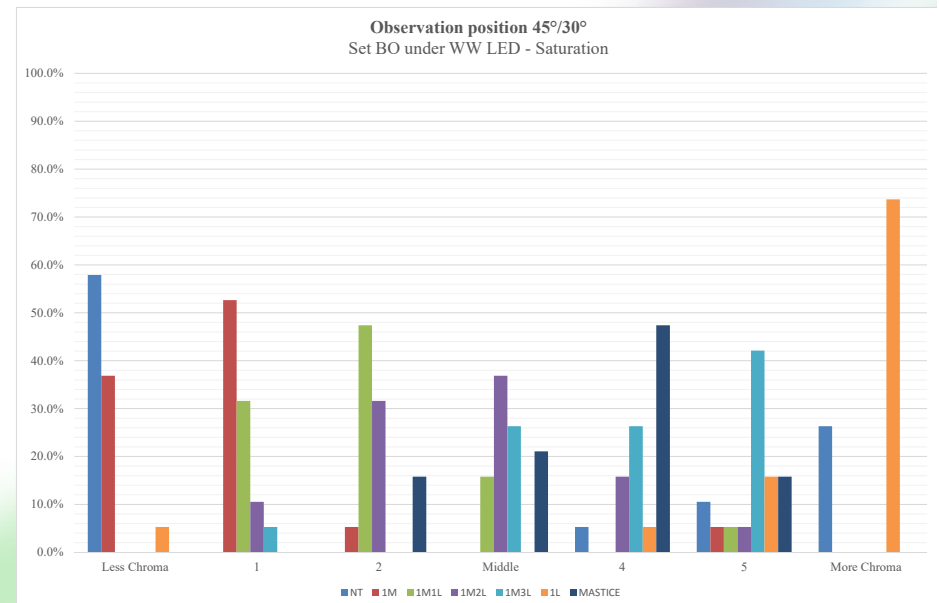
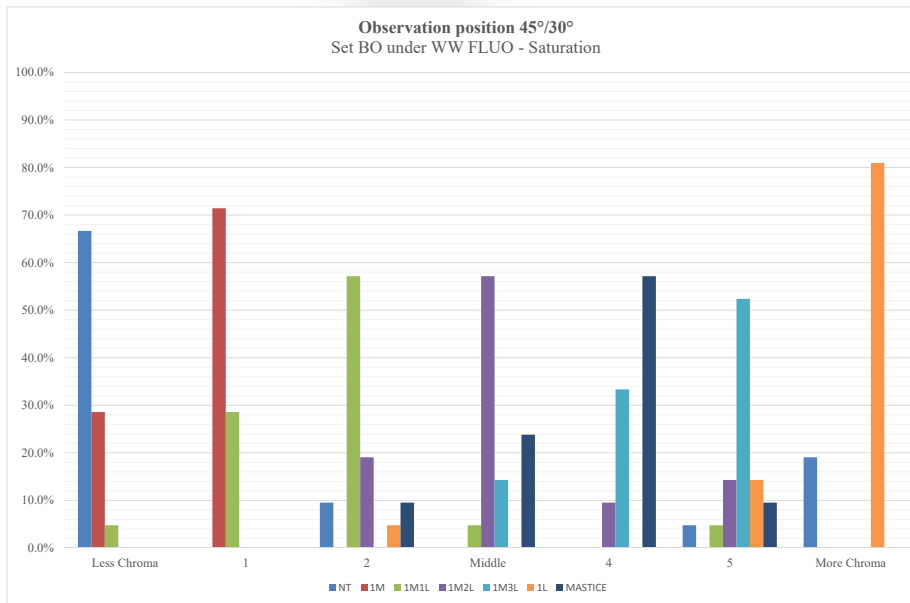
## Measured quantities:

- Spectral Reflectance (goniometer)

- Gloss

- Chroma  $L^*C^*h^*$

# Dispersion in saturation evaluation



FLUO

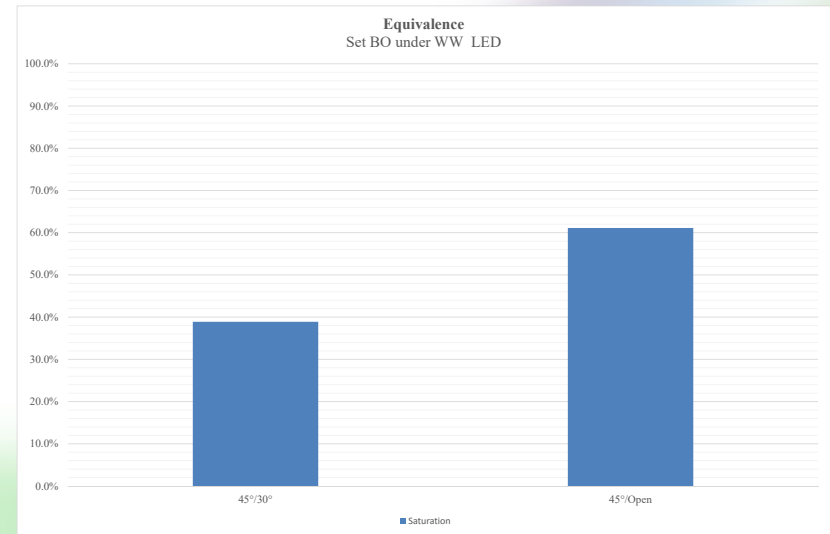
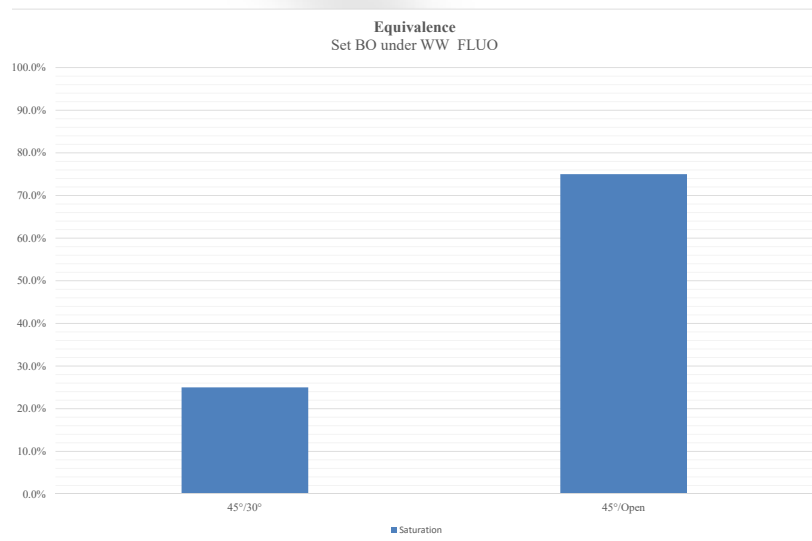
45/30

Chroma, C*, ranking measured @ 45/30							
	Lower C*						Bigger C*
WWL	BO_1M	BO_MASTICE	BO_1M1L	BO_1M3L	BO_NT	BO_1L	BO_1M2L
WWF	BO_1M	BO_1M1L	BO_MASTICE	BO_1M2L	BO_1M3L	BO_NT	BO_1L
Saturation ranking @ 45/30							
	Lower Saturation						More Saturation
WWL	BO_NT	BO_1M	BO_1M1L	BO_1M2L	BO_MASTICE	BO_1M3L	BO_1L
WWF	BO_NT	BO_1M	BO_1M1L	BO_1M2L	BO_MASTICE	BO_1M3L	BO_1L

LED



# Dispersion in saturation evaluation



FLUO

LED

Chroma, C*, ranking measured @ 45/30							
	Lower C*					Bigger C*	
WWL	BO_1M	BO_MASTICE	BO_1M1L	BO_1M3L	BO_NT	BO_1L	BO_1M2L
WWF	BO_1M	BO_1M1L	BO_MASTICE	BO_1M2L	BO_1M3L	BO_NT	BO_1L
Saturation ranking @ 45/30							
	Lower Saturation					More Saturation	
WWL	BO_NT	BO_1M	BO_1M1L	BO_1M2L	BO_MASTICE	BO_1M3L	BO_1L
WWF	BO_NT	BO_1M	BO_1M1L	BO_1M2L	BO_MASTICE	BO_1M3L	BO_1L

# CONCLUSIONS

- Sparkle/graininess ranking is directly related to the particle characteristics:  
Largest particles and distribution=higher sparkle/graininess
- Available measurement sparkle/graininess device fit homogeneously wit perceived quantity BUT what about abosolute values?

# CONCLUSIONS

- **Lightness** CIE  $L^*$  measurements not homogeneous with **brightness** evaluation: CCD camera are needed to differentiate sparkle/graininess from reflectance
- **Chroma** CIE  $C^*$  measurements not homogeneous with **saturation** evaluation:  $C^*$  considers only  $a^*$   $b^*$  with gloss strong variation in  $L^*$  occurs

# CONCLUSIONS

- LED allows a better perception of Sparkle / graininess, brightness and help in gloss
- Problems with saturation
- With LED lower number of equivalences in the perception of sparkle graininess and saturation
- Easier to perceive sparkle / graininess
- Able to highlight differences in particle shape