Living Sparkle as a special peculiarity of visual texture

Workshop
‚Challenges on the measurement of sparkle and graininess', Espoo, 5th November 2019

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„Living Sparkle as a special peculiarity of visual texture„

Agenda

0. Introduction

1. Sample making using calculated pigment coverage

2. Measurement of orientation distribution using x-ray tomography

3. Measurement of living sparkle using goniometric images

4. Extraction of 'living sparkle data' from the movies

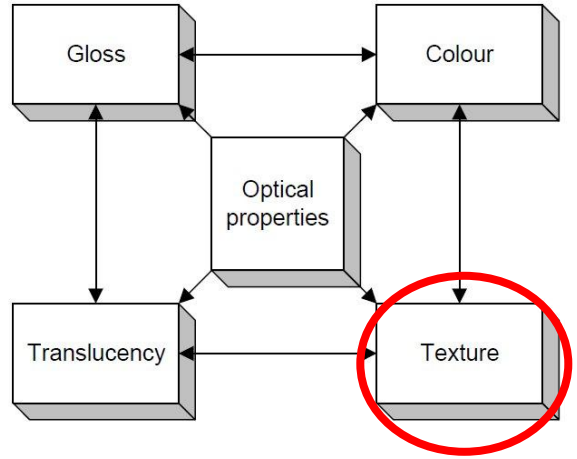
0. Introduction

Sun Sparkle on Ocean Surface

Car covered with Swarovski crystals

Meteorites in the deep space

Diamond Tennis Bracelet



[CIE2006] A framework for the measurement of visual appearance

Sparkle (ASTM E284):
The aspect of appearance of a material that seems to emit or reveal **tiny bright points of light** that are strikingly brighter than their immediate surround …

0. Introduction

Sun Sparkle on Ocean Surface

Car covered with Swarovski crystals

Meteorites in the deep space

Diamond Tennis Bracelet

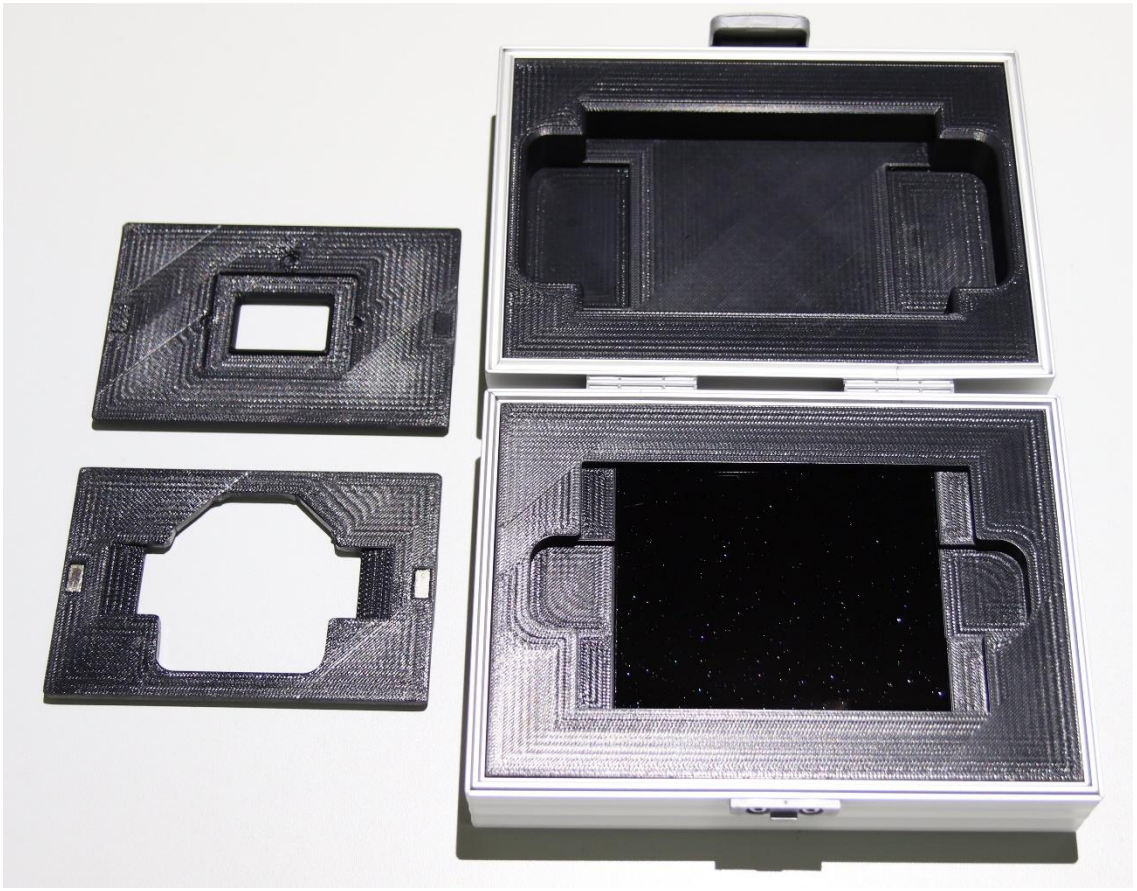
Sparkle (ASTM E284):

… and are made **more apparent** when a minimum of one of the contributors (observer, specimen, light source) **is moved**.

0. Introduction

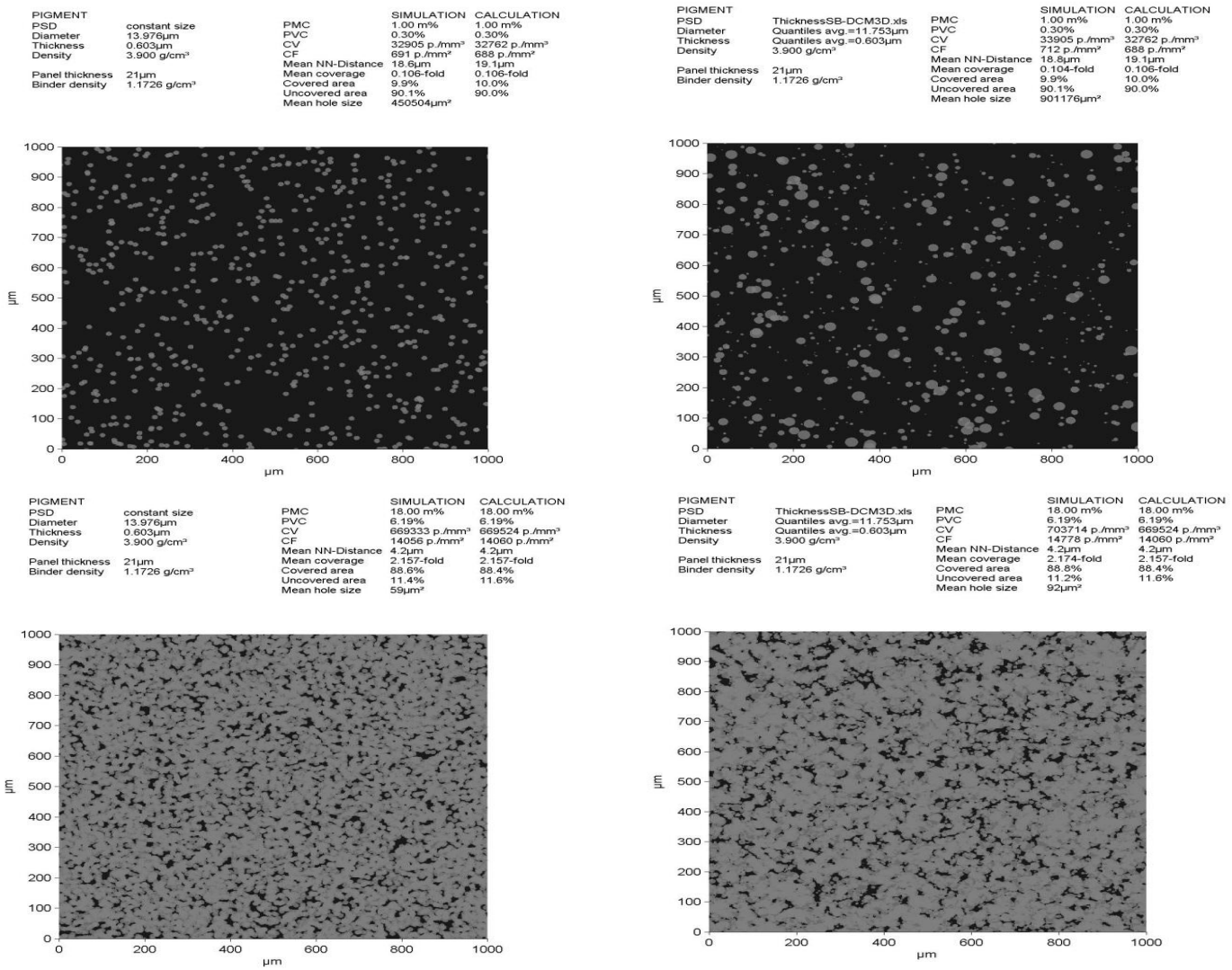
„Living Sparkle®"

1. sample making using calculated pigment coverage



Reference Samples for Textures: Sparkle, Coarseness with fixed N(mm^{-2}), Cov(%)

1. sample making using calculated pigment coverage



Scheme of particle coverages (top view)

PMC

PVC

N[cm^{-3}]

ρ

N(Di, di)

T

$$PMC \sim \frac{\rho \sum_{i=1}^{N} d_i D_i^2}{T\,S}$$

$$PMC \sim F_{Poisson}[Cov, N]$$

PVC

N[cm^{-3}]

n[cm^{-2}]

Situation as in diffuse Illumination, because no consideration of **Particle Orientation**

MERCK

2. measurement of orientation distribution using nano x-ray tomography

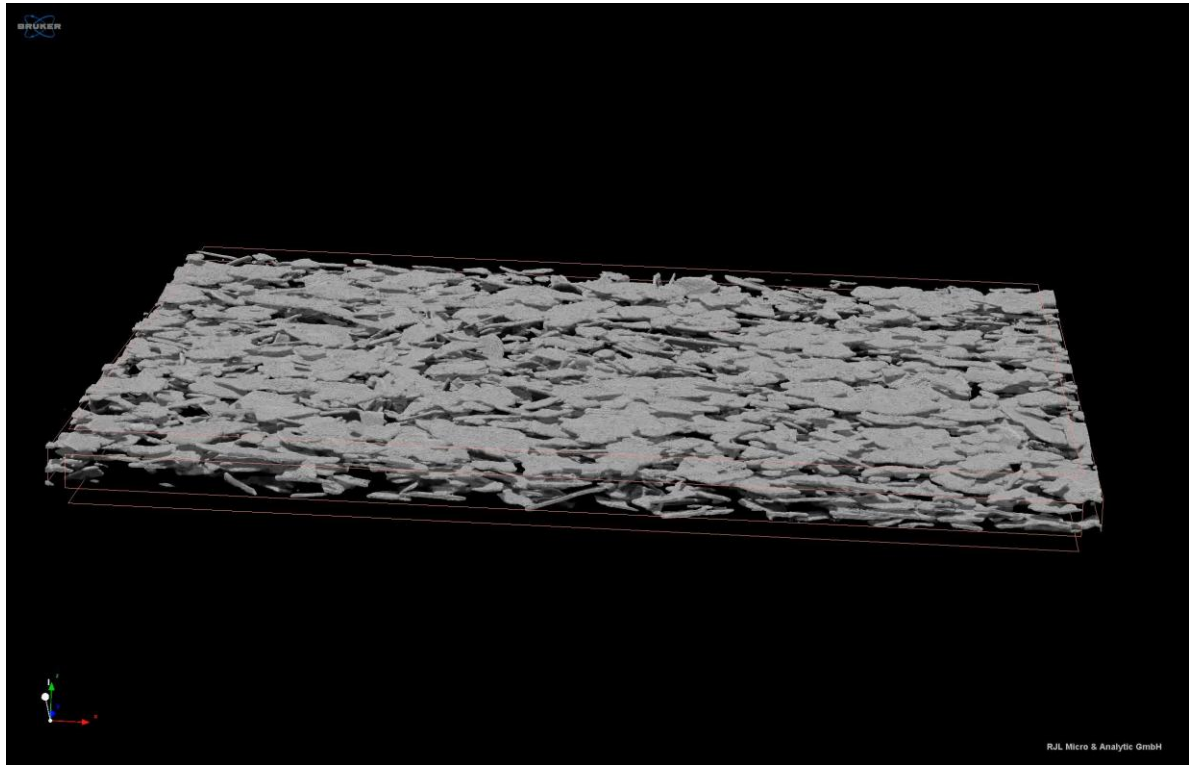
Particle Orientation (Skyscan2211), see also X-ray microscope Xradia 810 Ultra (Poster)

Color coding:

Strong desorientation

Medium desorientation

Low desorientation



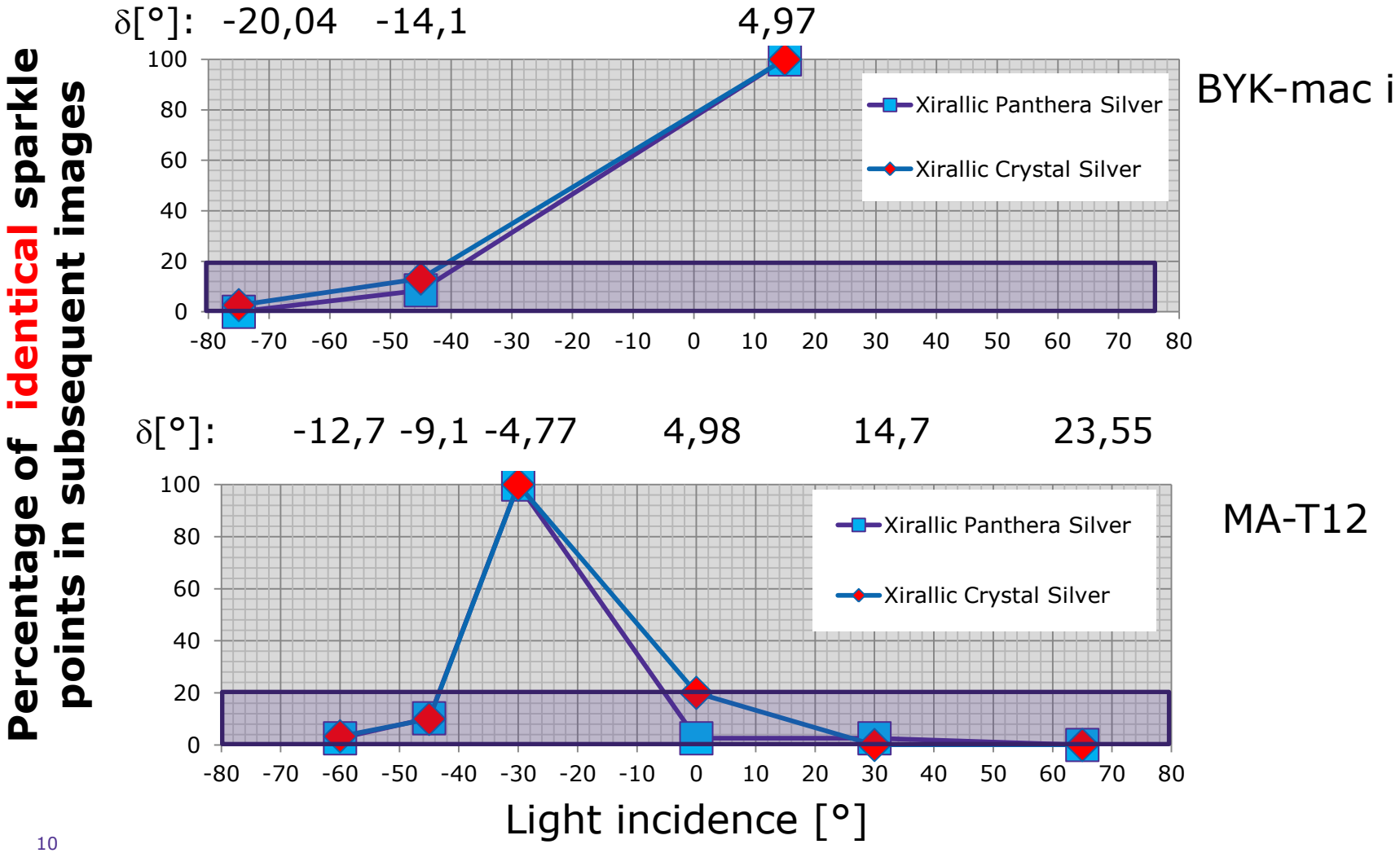
Poster 1: EVALUATION OF EFFECT PIGMENT ORIENTATION USING SEM, TEM AND X-RAY CT ANALYSIS - CONCLUSION FOR INTERPRETING GONIOSPECTROPHOTOMETRIC DATA, **Poster 2:** EFFECT PIGMENTS IN COATINGS: EVALUATING THE NANOSTRUCTURE IN 2D AND 3D BY MEANS OF ELECTRON AND X-RAY MICROSCOPY

3. measurement of sparkle using goniometric images

Instrument ->	BYK-mac i (BYK-Gardner)	MA-T12 (X-Rite)	Gonio 2π (Opsira) Red Scarlet (Red)	Smartzoom 5 (Zeiss) Rotation Table (PI)	EOS 400D (Canon) Dome Lights SAW3 (Polytec)
diffuse/directed	yes / yes	yes/yes	no / yes	no / yes	yes / no
Polar Angle (Detector)	0°	15°	+75° … -75°	+45° … -45°	0°
Azimuthal Angle (Detector)	0°	0°	0° … 360°	0° … 360°	0°
Polar Angle (Illumination)	15°, -45°, -75°	-60°, -45°, -30°, (-20), 0°, 30°, 65°	+75° … -75°	+45° … -45°	20°… 90°
Azimuthal Angle (Illumination)	0°	0°	0° … 360°	0° … 360°	all (20°… 90°)

3. measurement of living sparkle using goniometric images

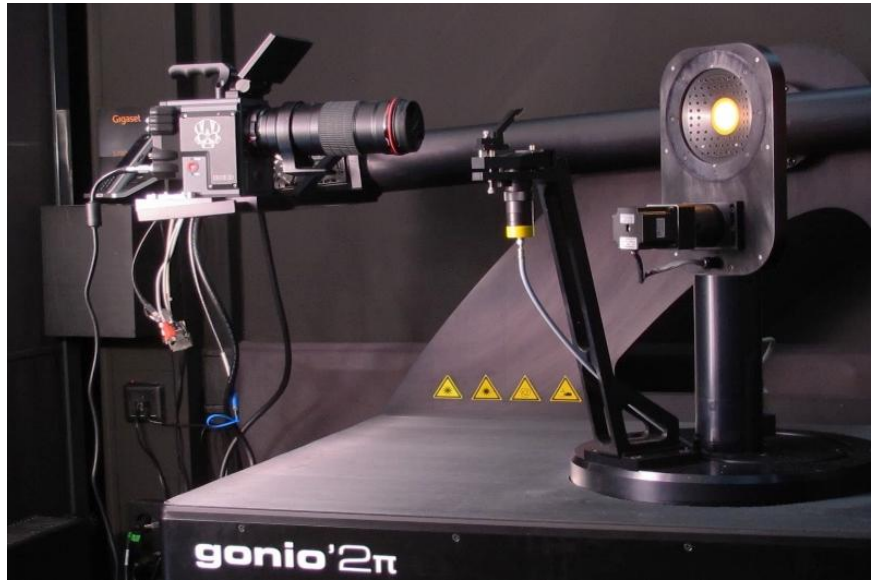
Why BYK-mac i and MA-T12 are not able to catch living sparkle?



Due to the big angular differences between the subsequent Particle des-orientation angles δ both instruments are not able to follow the living sparkle behavior created by the limited angular persistence of sparkle points.

3. measurement of living sparkle using goniometric images

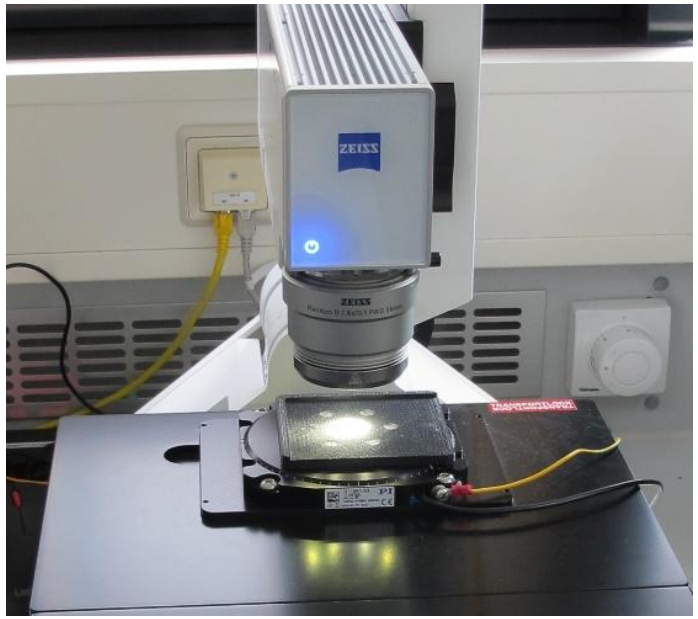
Gonio 2p



Full-HD Gonio-Movies/Images
Movement of illumination, detector & sample

Gonio Colorimetry &
Angular Sparkle Persistence

SmartZoom5 & PI rotation stage



Microscopy at angular dependent
illumination/detection & sample rotation

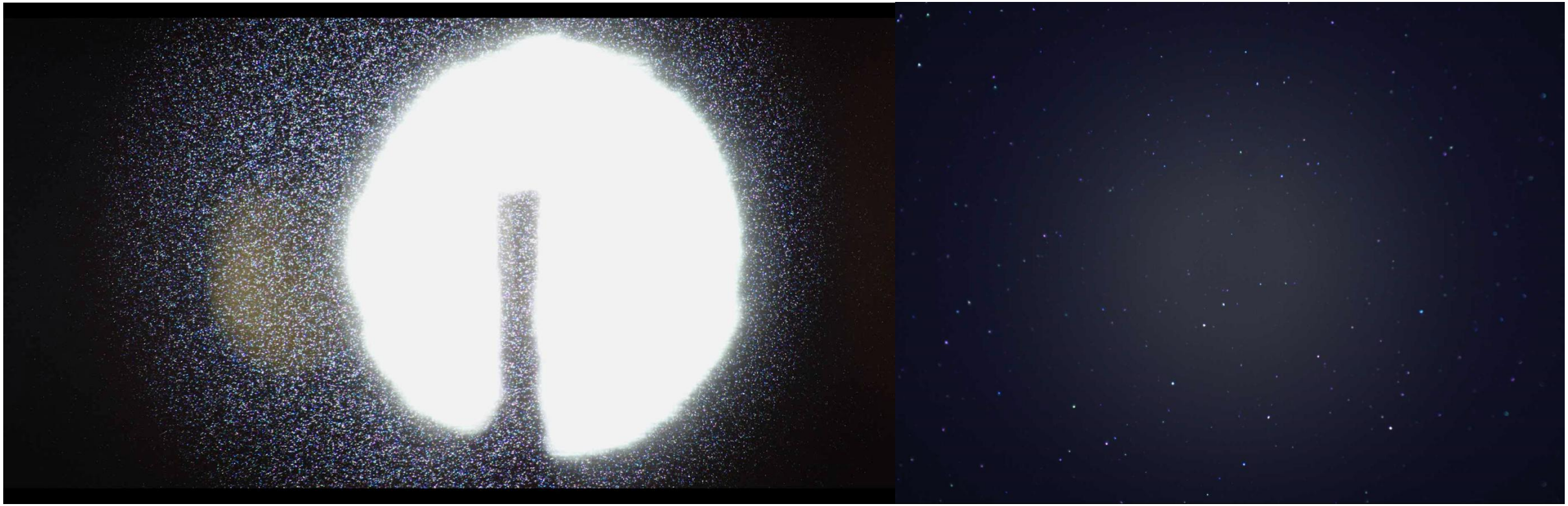
Microscopic Gonio Colorimetry
& Angular Sparkle Persistence

3. measurement of living sparkle using goniometric shots

full gonio-movies made by:

Gonio 2p and Red Scarlet camera

Smartzoom 5 and PI rotation table



Xirallic® Panthera Silver – PMC 1%, 10 µm layer thickness

observation 0°, illumination from 0 – 75°

coaxial zoom 40, inclined 10° to the optical axis

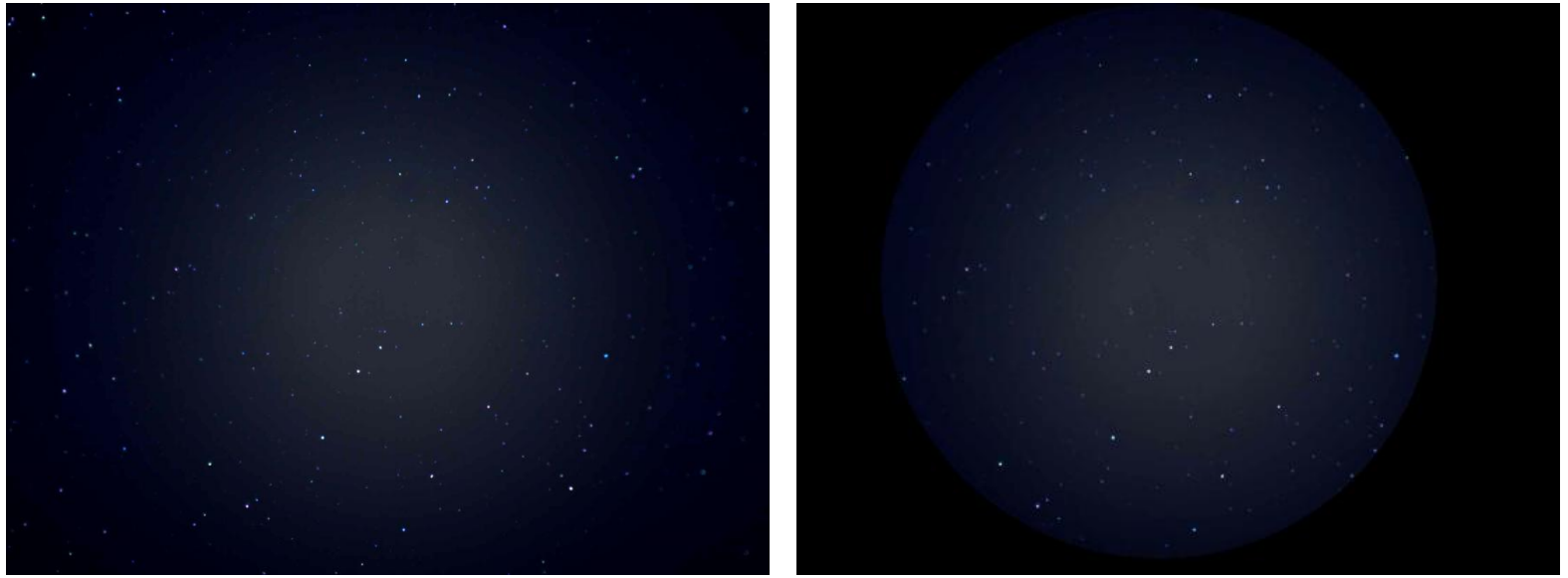
4. extraction of 'living sparkle data' from the movies

SmartZoom5 & Rotation Stage:

Zoom: 40x, Illumination: coaxial, light incidence & detection 7°, Rotation: 10° per s ➡ each frame: 1°

Microscopy at angular dependent illumination/detection & sample rotation ➡ **“Living Sparkle” movies**

Xirallic Panthera Silver, PMC 1%



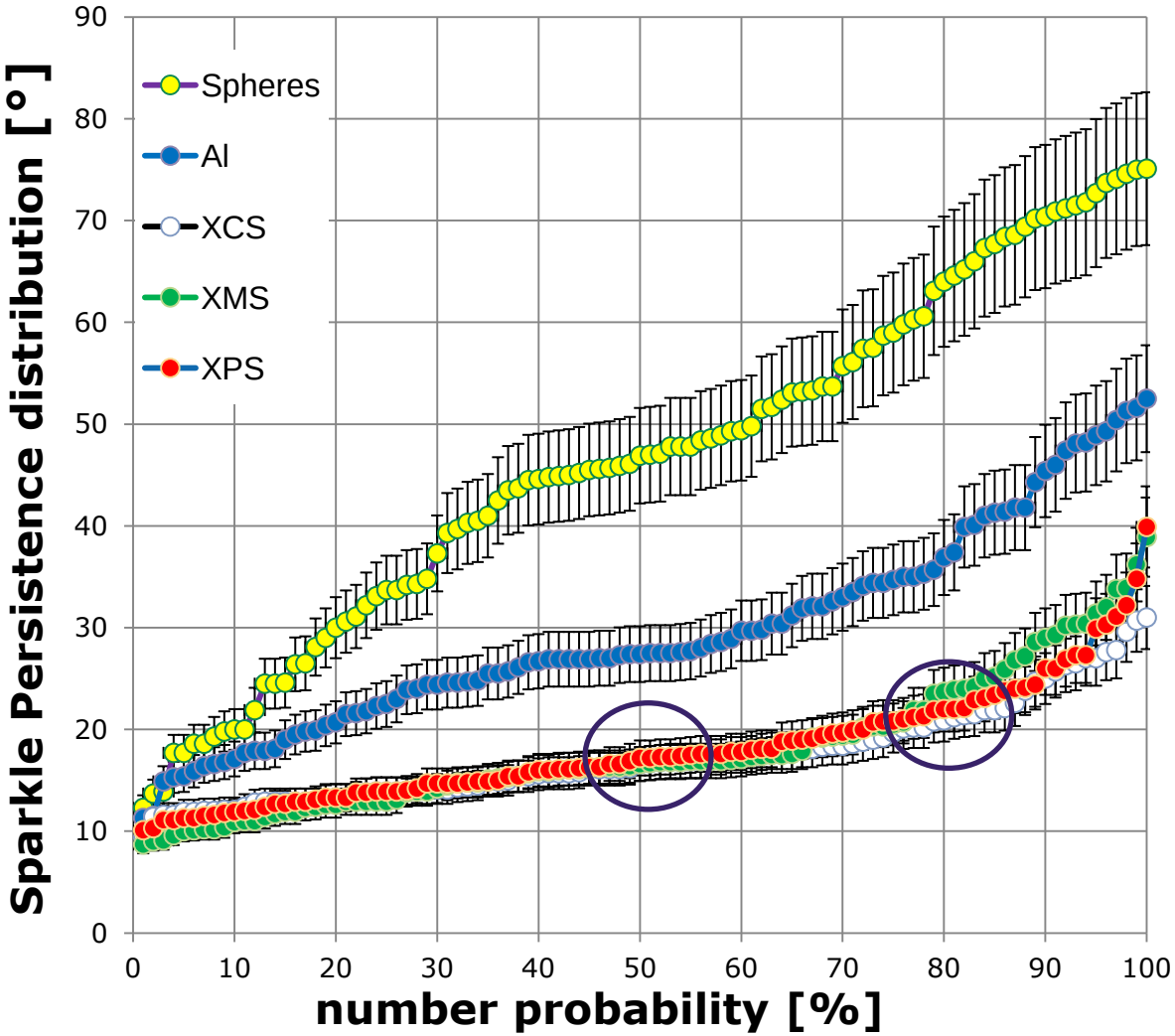
360° sample rotation ⟶ computed reverse rotation

Calculation of Key-Parameter:

„number of sparkle spots“, „spot size“, „spot intensity“, „angular persistence“ …

4. extraction of 'living sparkle data' from the movies

Cumulative sparkle persistance distribution Gonio 2π and Red Scarlet camera



Spheres

Al,

Xirallic®

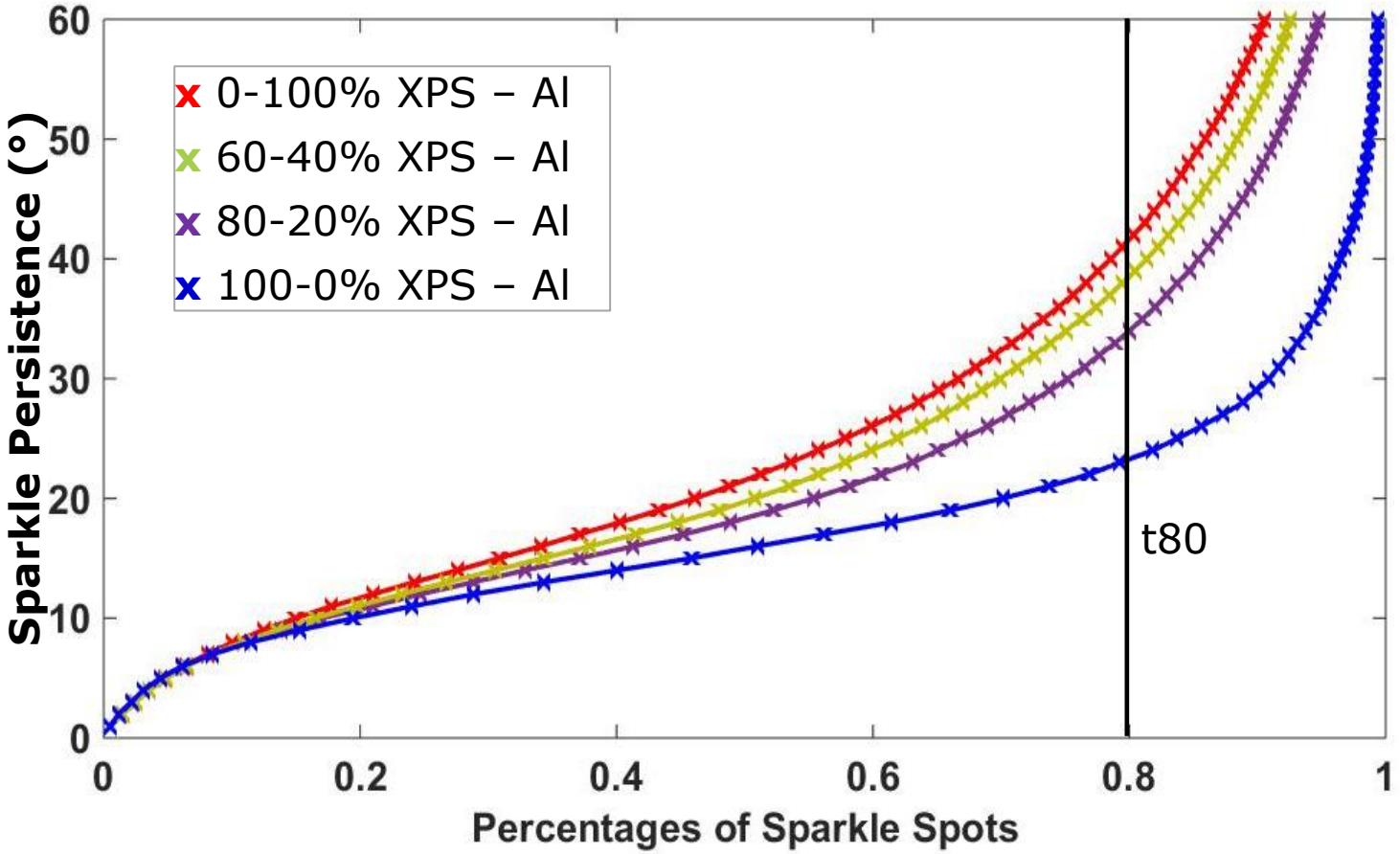
Sparkle Persistence:
Angular Range, in which a certain sparkle point is visible.

The **Cumulative sparkle persistance** is the digital description of a dynamic sparkle effect. It can be calculated from movies (shown at the Pigments & Color Science Forum, Alicante 2017)

4. extraction of 'living sparkle data' from the movies

Cumulative sparkle persistance distribution SmartZoom5 & Rotation Stage

Sample	Persistence t80 (°)
100% Al	41.4
60% XPS & 40% Al	39.2
80% XPS & 20% Al	34.2
100% XPS	23.8



Mixture series Xirallic Panthera Silver (XPS) & Alpate EMR-D762E Al (PMC 18%)

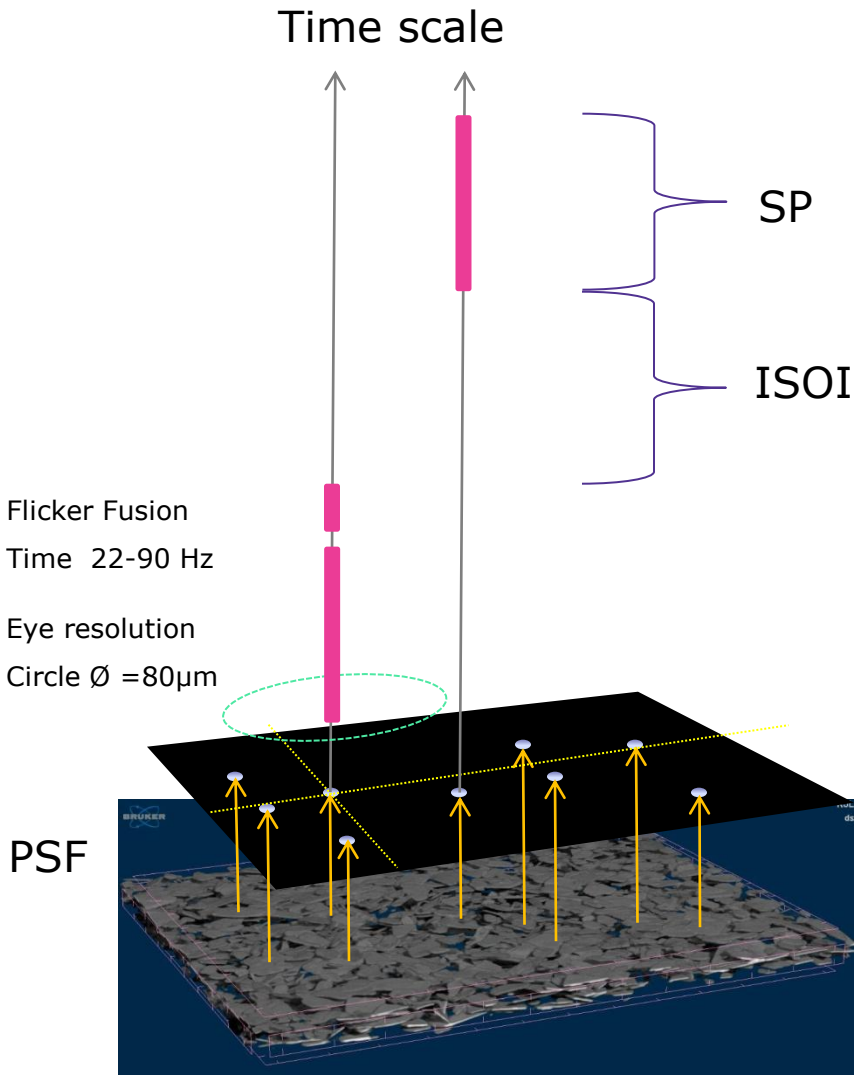
4. extraction of 'living sparkle data' from the movies

Physical Model

Virtual Movement

Korte's Laws – Dependence of virtual movement of sparkle points on four parameters:

1. Time Intervall (ISOI=Interstimulus Onset Interval)
2. Lateral distance
3. Sparkle Point Intensity (relative to the background, Contrast)
4. Duration of Sparkle (Sparkle Persistence)



To be taken into account:

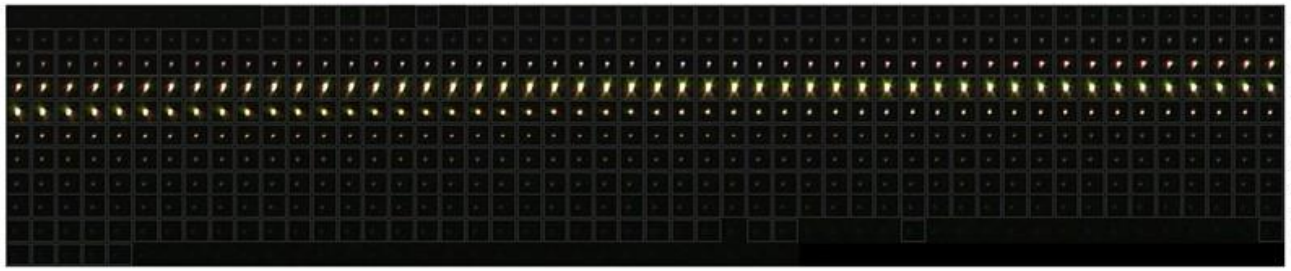
Sample Rotation Speed
Angular Illumination Speed
CamCorder Speed (Frames/s)
Observer Speed

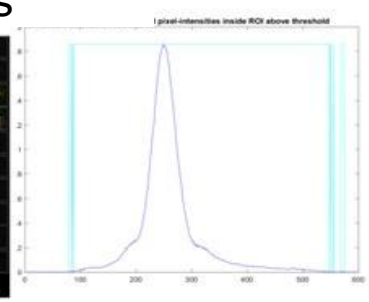
4. extraction of 'living sparkle data' from the movies

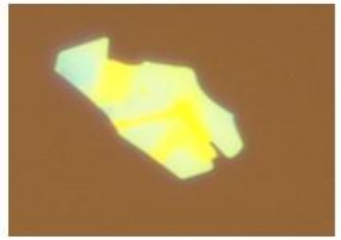
Biography of Sparkle Points

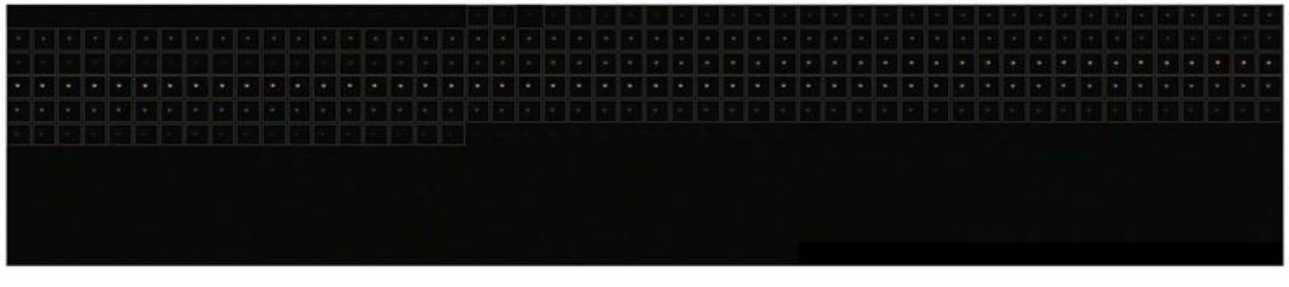
Types of Sparkle Points

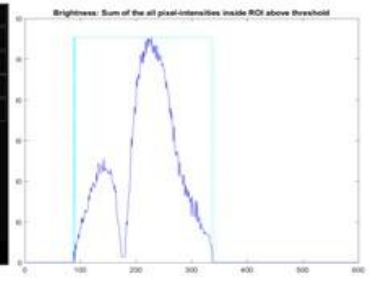
due to …

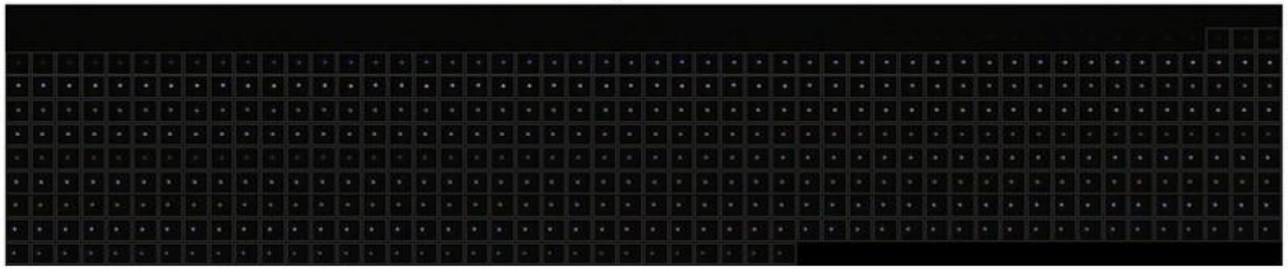


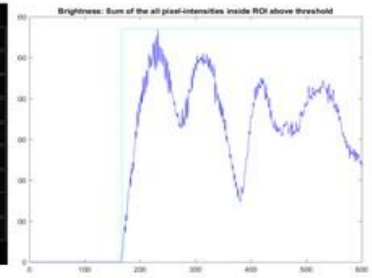












Sequence of individual sparkle point images as a function of illumination angle

„Living Sparkle as a special peculiarity of visual texture„

Thank you for your Attention!

With contributions of

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