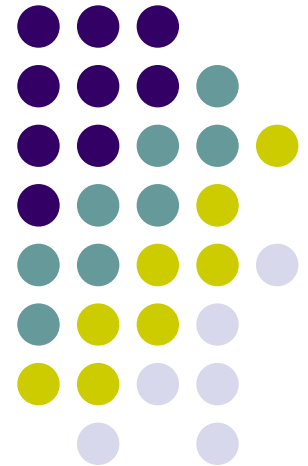


Measurements with ICAM and ICAM Viewer

October 8, 2009

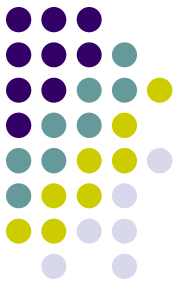


ICAM Colorimeter



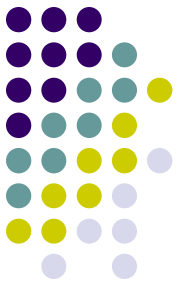
- ICAM is a filter based high accuracy 2D colorimeter that measures absolute color and luminance on still images, moving images and even parts of a frame period (time slicing).





ICAM Specifications

- Imaging, CCD-based system
- 3 filters, X, Y, Z
- Chromaticity repeatability: $x,y \pm 0.0002$
- Luminance repeatability: $\pm 0.035\%$
- Min. luminance 0.00005 cd/m^2
- Max. luminance $3,000,000 \text{ cd/m}^2$
- Filters are especially designed for the optical components in ICAM
- Very stable over time due to Ultra hard coated filters



ICAM Specifications 2

- Tristimulus Values according to 1931 2° Colormetric and Photometric Values
- Dynamic Range – 1350:1
- CCD- 1280x960 pixels
- Focus 225mm - ∞
- F# Range 3.5 - 28
- Field of View
 - Vertical +/- 5.1°
 - Horizontal +/- 6.7°

ICAM Features



- A measurement looks like a normal image, but every pixel contains X, Y, Z coordinates
- Versatile system measures still images, moving images and “time-slicing” of frame periods for advanced R&B purposes
- uniformity, Contrast ratio, Color gamut, Mura-types like line, band, gap, BLU-mura
- Motion induced color-blur, MPRT, moving artifacts
- Temporal measurements down to fractions of a frame period
- Standard software and ActiveX interface



ICAM Calibration

- Several factory calibrations:
 - Standard calibration, for general use
 - Narrow band calibration, e.g. LED measurements
 - Local variations, for high accuracy on e.g. BLU with a very spiked spectrum
 - 3-point calibration, User calibration for R, G, B displays
 - Surface colours, factory calibration mainly for ICAM Viewer
- Factory calibrations are granted for 2 years



ICAM Viewer

- Measurement with ICAM Viewer on a Kindle.
- Illumination: D65 in app. In 45°
Measurement in 0°
- Measurement area:
 - 280 mm x 210 mm



ICAM Viewer Calibration

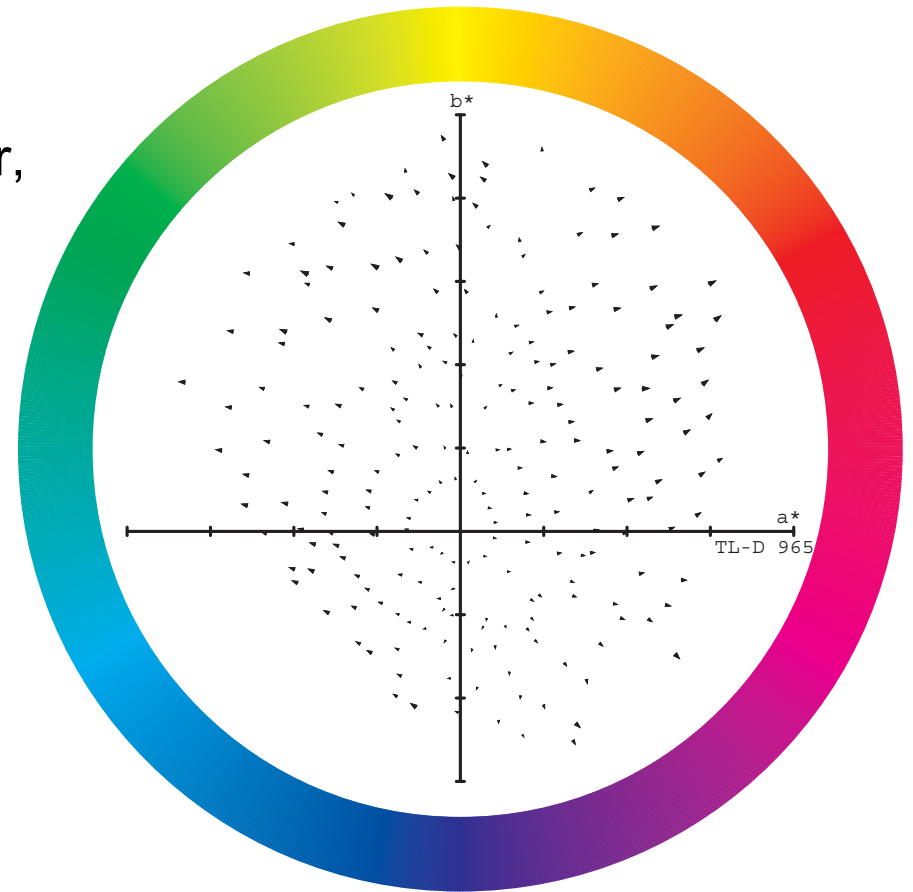


- “Surface colors” is made especially for the ICAM Viewer
- Spectrum of the burned in lamps are measured in a 6.5 feet integrating sphere by calibrated and accredited high accuracy spectrometer (1 nm scan).
- Tiles with reflectance measured at NIST/NPL are placed in the ICAM Viewer
- By Mathematics the color of the tiles is determined and added into the calibration engine of the ICAM viewer (traceable calibration)
- With every measurement a reference tile is measured in order to keep track of even minor variations in the light. This data is stored in the final measurement and is used for the calculation of reflectance

ICAM Viewer std. Light Source



- Color rendering index 98
- Color D65 or D50 (by specification from manufacturer, final measurement done y Delta)
- Lamp warm up is automatically tested and burn time is logged (at around 10-15,000 hrs the light source needs to be changed)

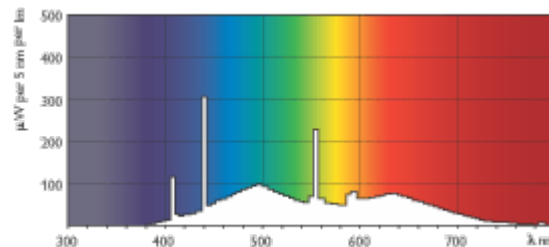


Color rendering index for the D65 light source

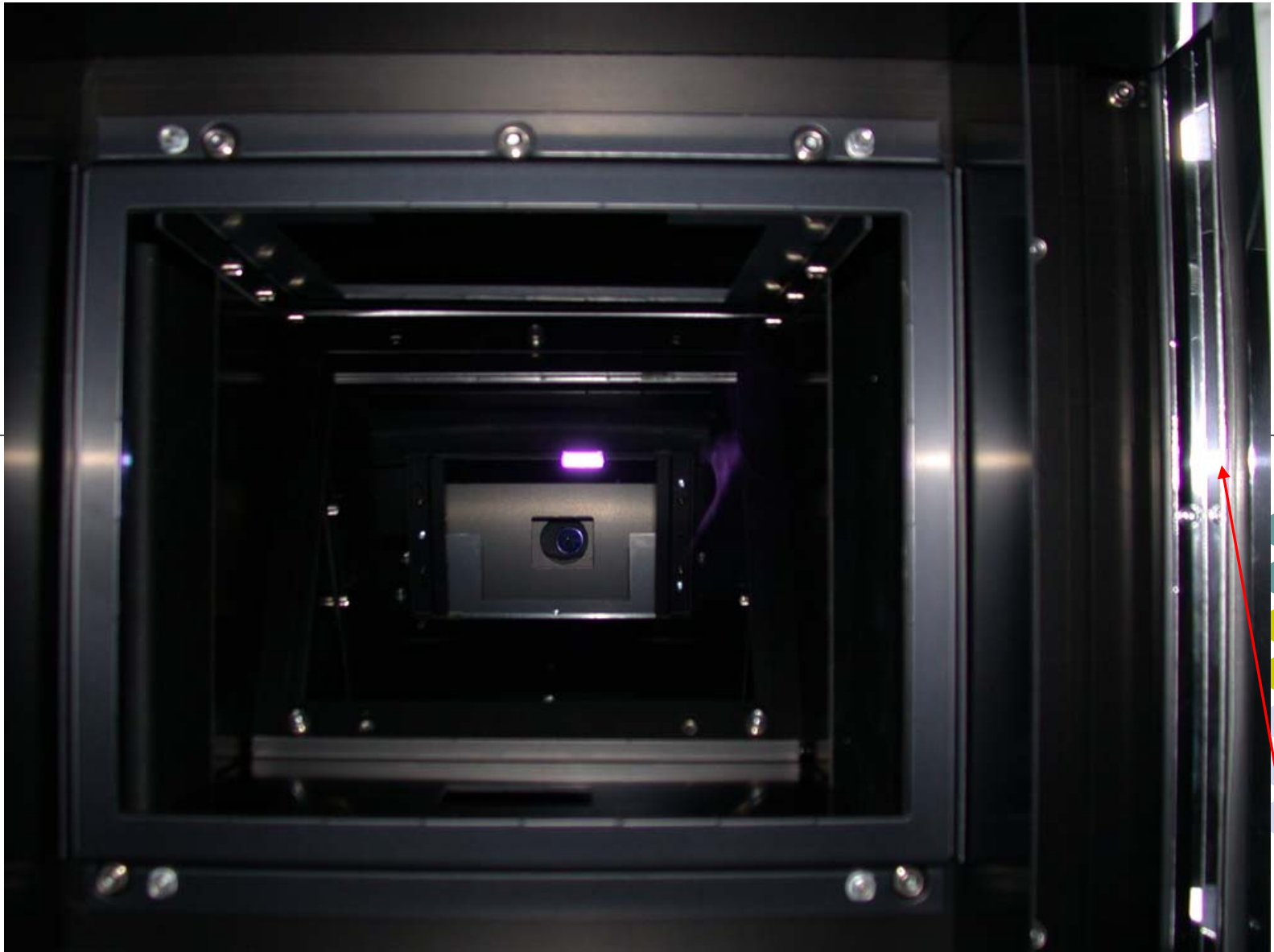
ICAM Viewer std. Light Source



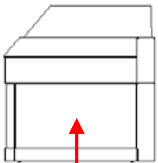
- In addition to the standard light source a light source based on customer request can be added. Examples are UV or F2. Both light sources can be controlled individually (uniformity is less, but software calibration can be done).
- On request other light sources can be mounted as the high uniformity light source.



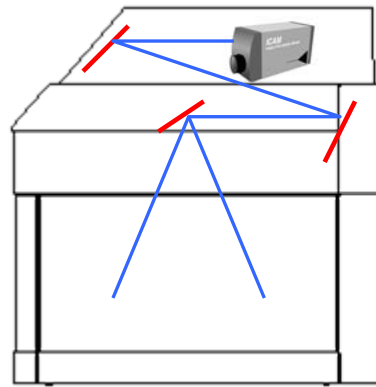
Spectrum of the D65 light source



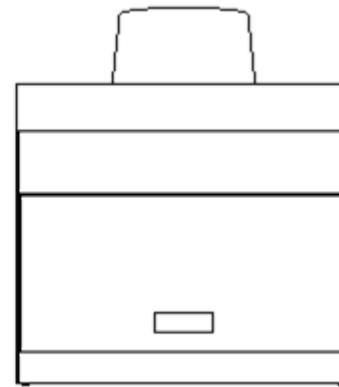
to the right
ICAM's lens can be seen in the middle



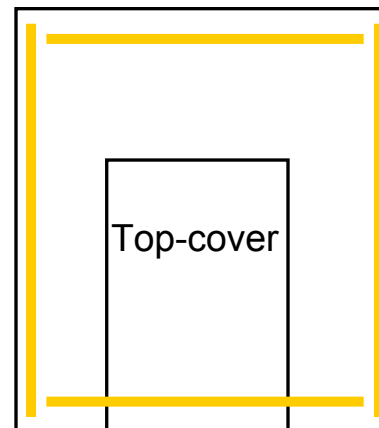
Illumination system



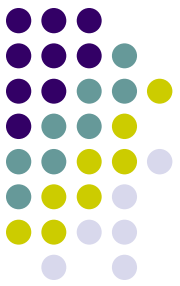
Side



Front



Back



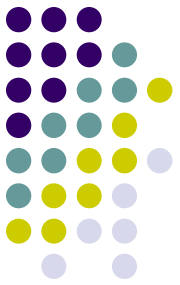
Reflection of E-paper

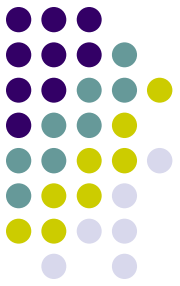
- Measurement with ICAM Viewer on a Kindle.
- Illumination: D65 in app. In 45°
Measurement in 0°
- Measurement area:
280 mm x 210 mm



Delta ICAM Viewer

- Measurements of Kindle2
- July 7, 2009
- By Jens Jensen, Delta

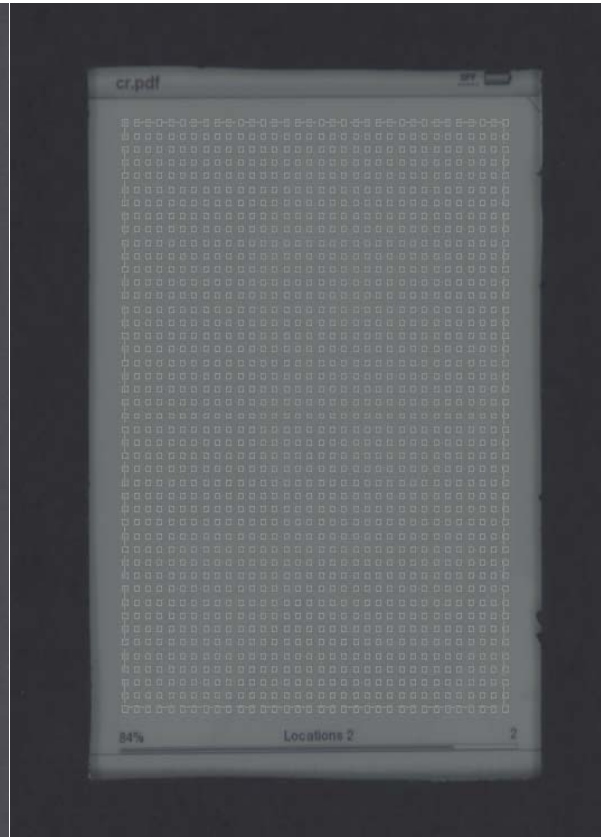




Reflection measurement of a Kindle

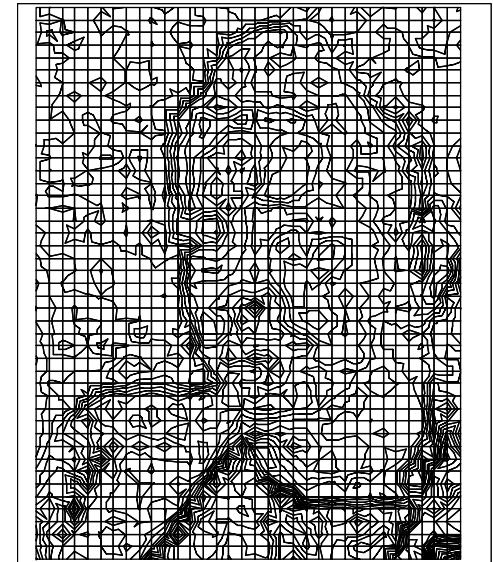


Measurement of white screen



Sampling of 34 columns and 45 rows in 5 by 5 points

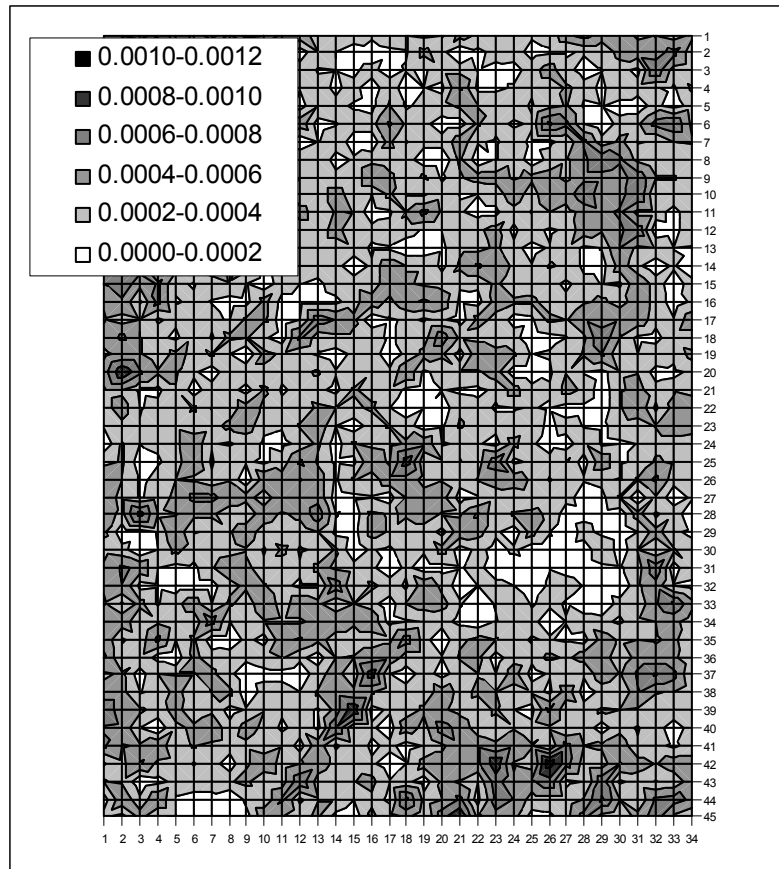
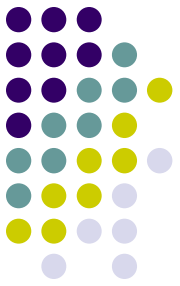
Reflection:
Average: 40.4 %
Standard deviation: 0.67 %
CV [%] = 1.7 %



Iso – reflection curves

Reflection measurement of a Kindle

- Colour -



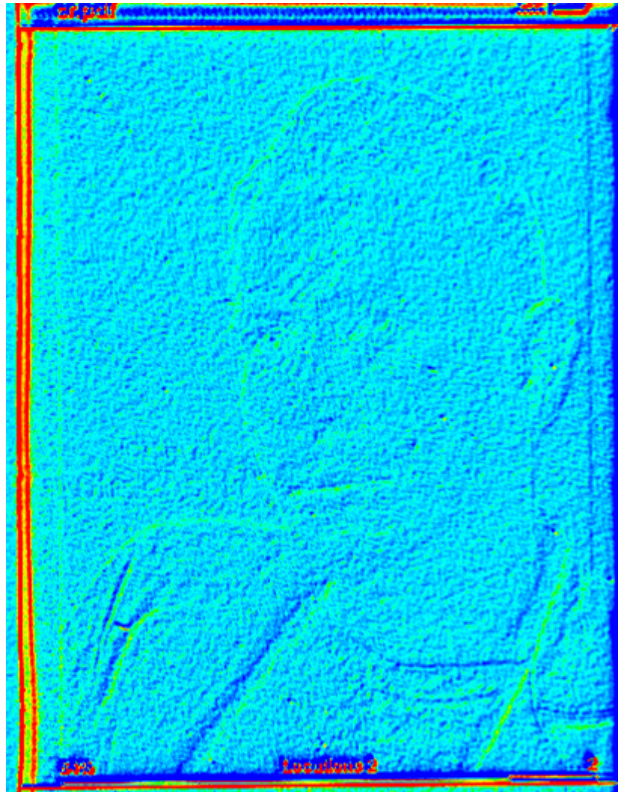
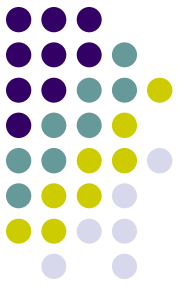
Colour variation as $\Delta u'v'$:

Average $\Delta u'v'$: 0.0003

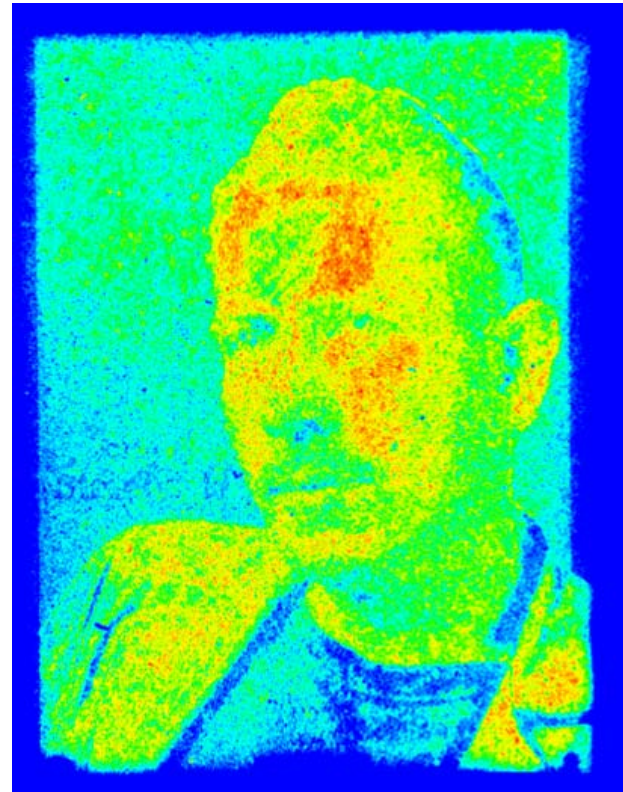
This magnitude is in the noise region of the measurement. So no colour variation detected.

The light source used for illumination has the Correlated Colour Temperature of 6460 K while the reflected light has the Correlated Colour Temperature of 6890 K. The reflected is a little more bluish.

Reflection measurement of a Kindle - Image sticking -



The measurement result replaced by the calculated gradient in each pixel.

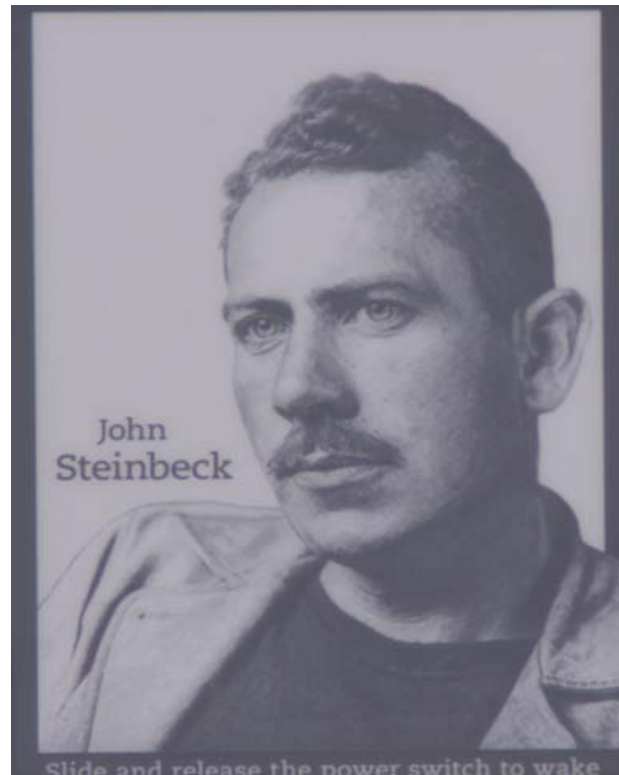
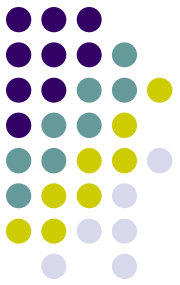


The measurement result shown as false colour luminance.

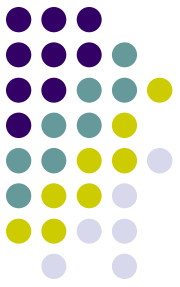
The magnitude of the stucked image is app. 1% to 4%.

Reflection measurement of a Kindle

- Source of sticked image -



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