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LCAM
CREATIVE R&D

Application of segmentation method for cotton trash and color measurement

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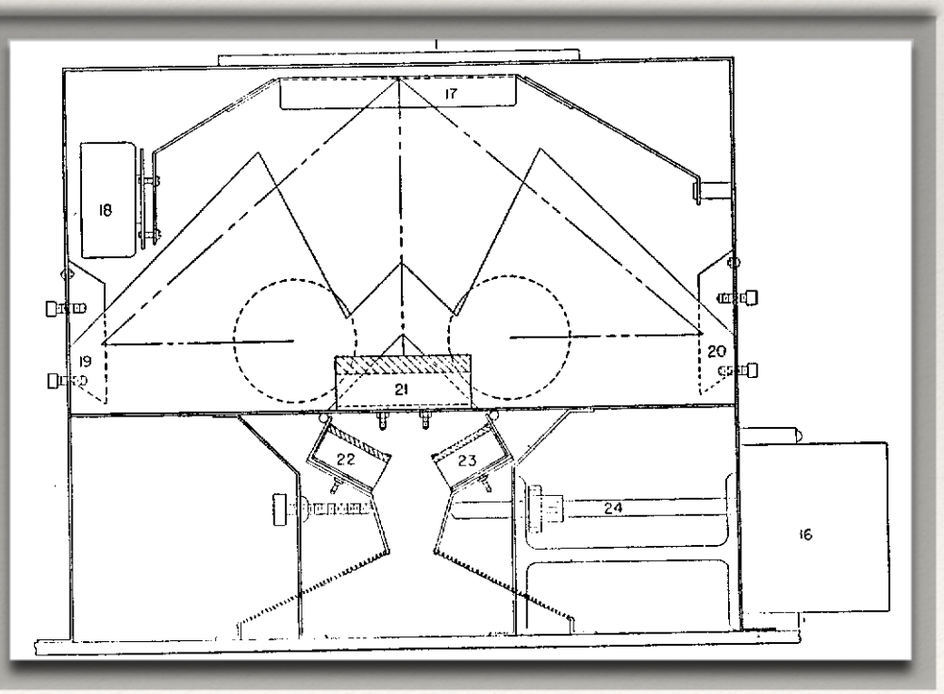
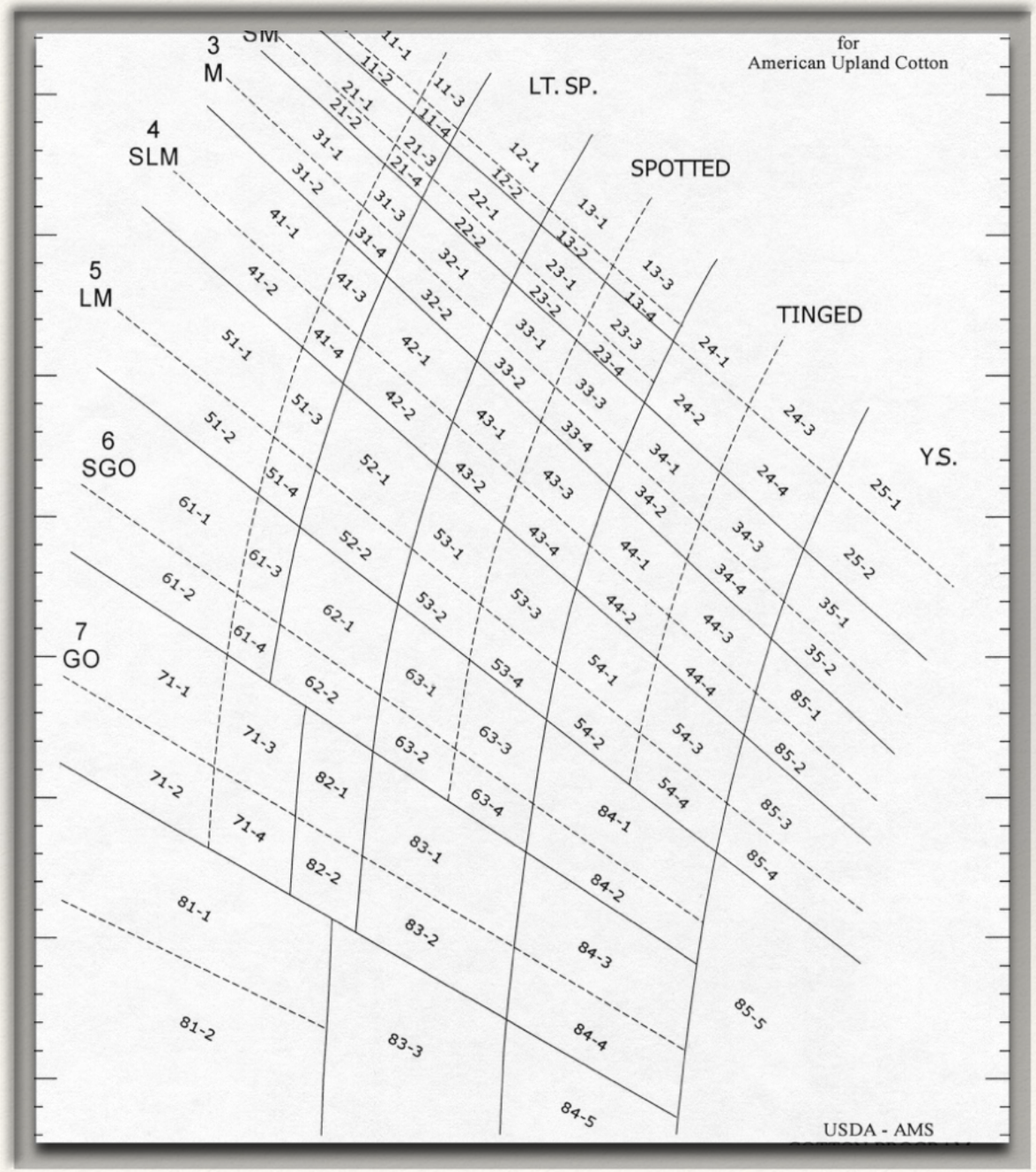
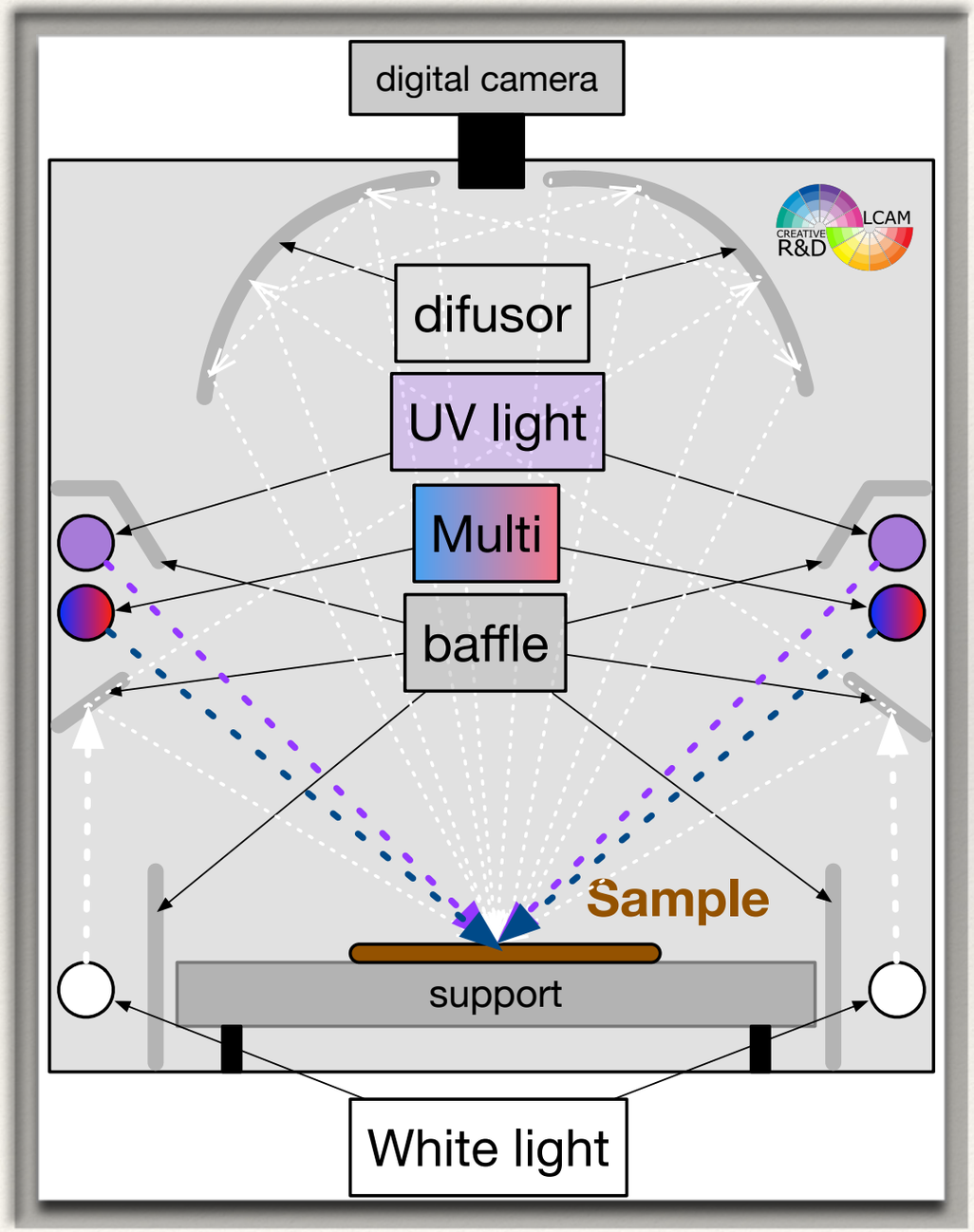
Cotton grading



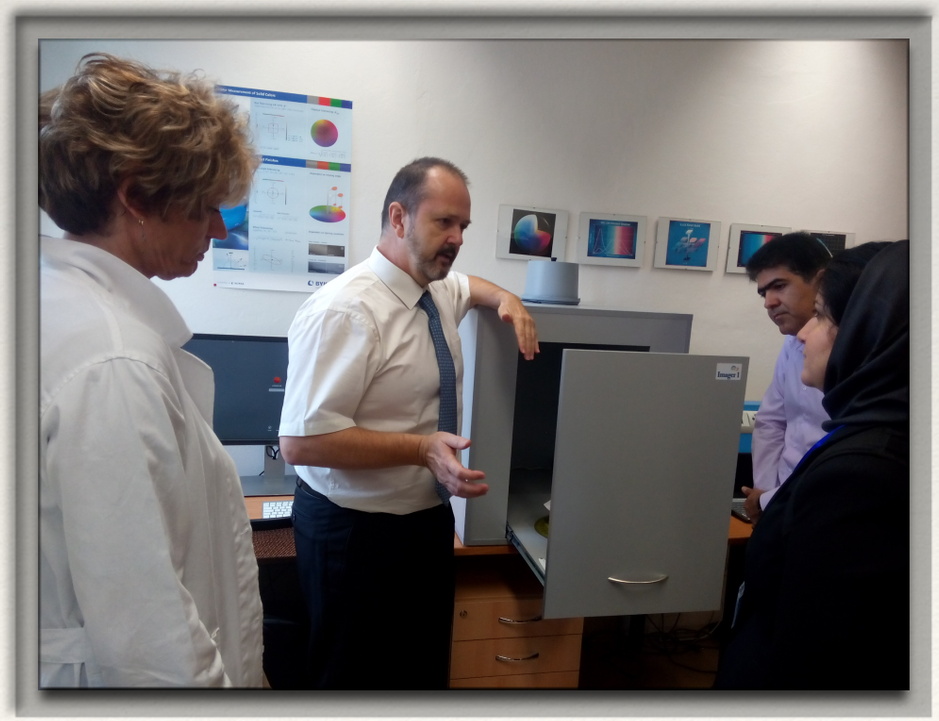


LCAM Imager

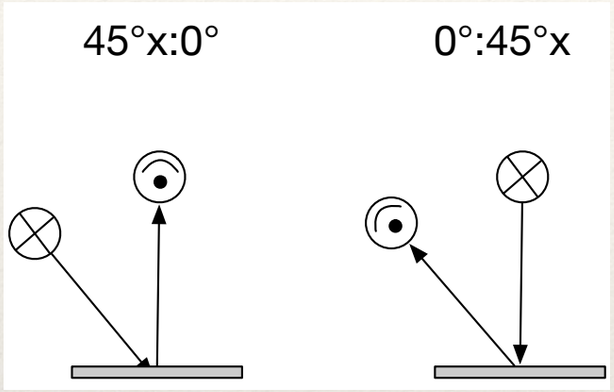


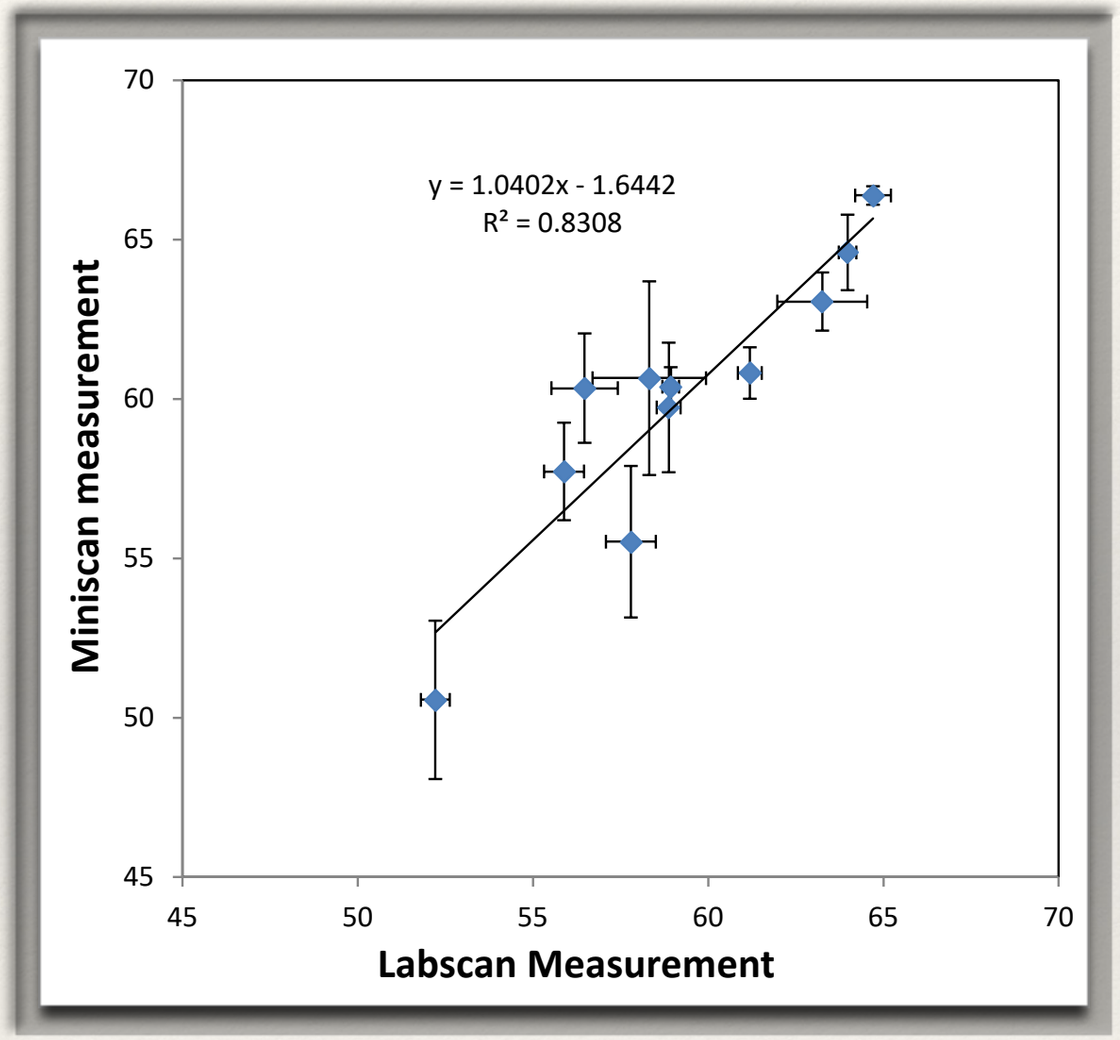
Multispectral Imaging System

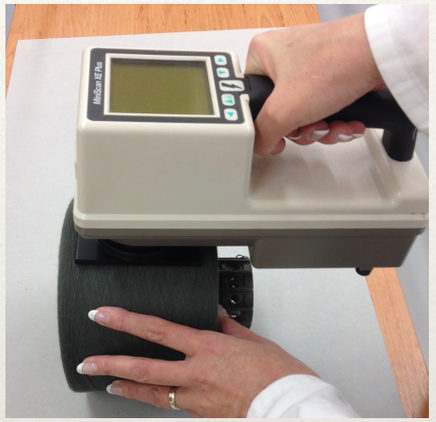
- 6000 x 4000 px
- 18 chanels
- replaceable daylight simulator
- support with 360° table



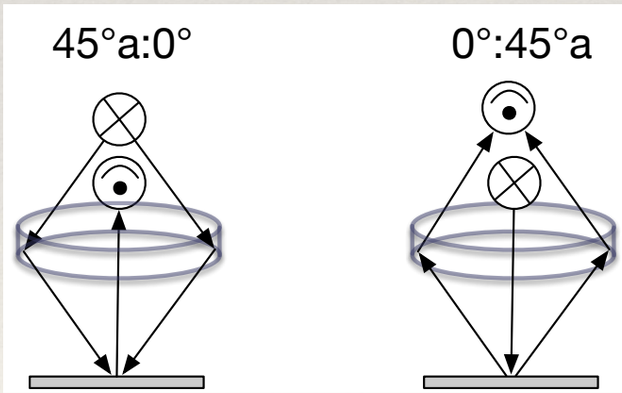
Helmholtz reciprocity?

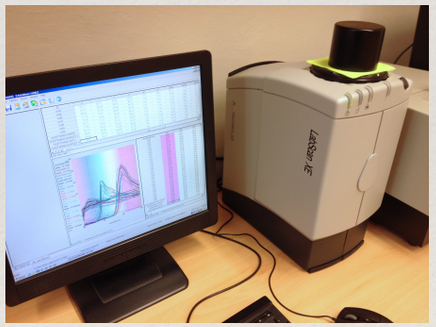






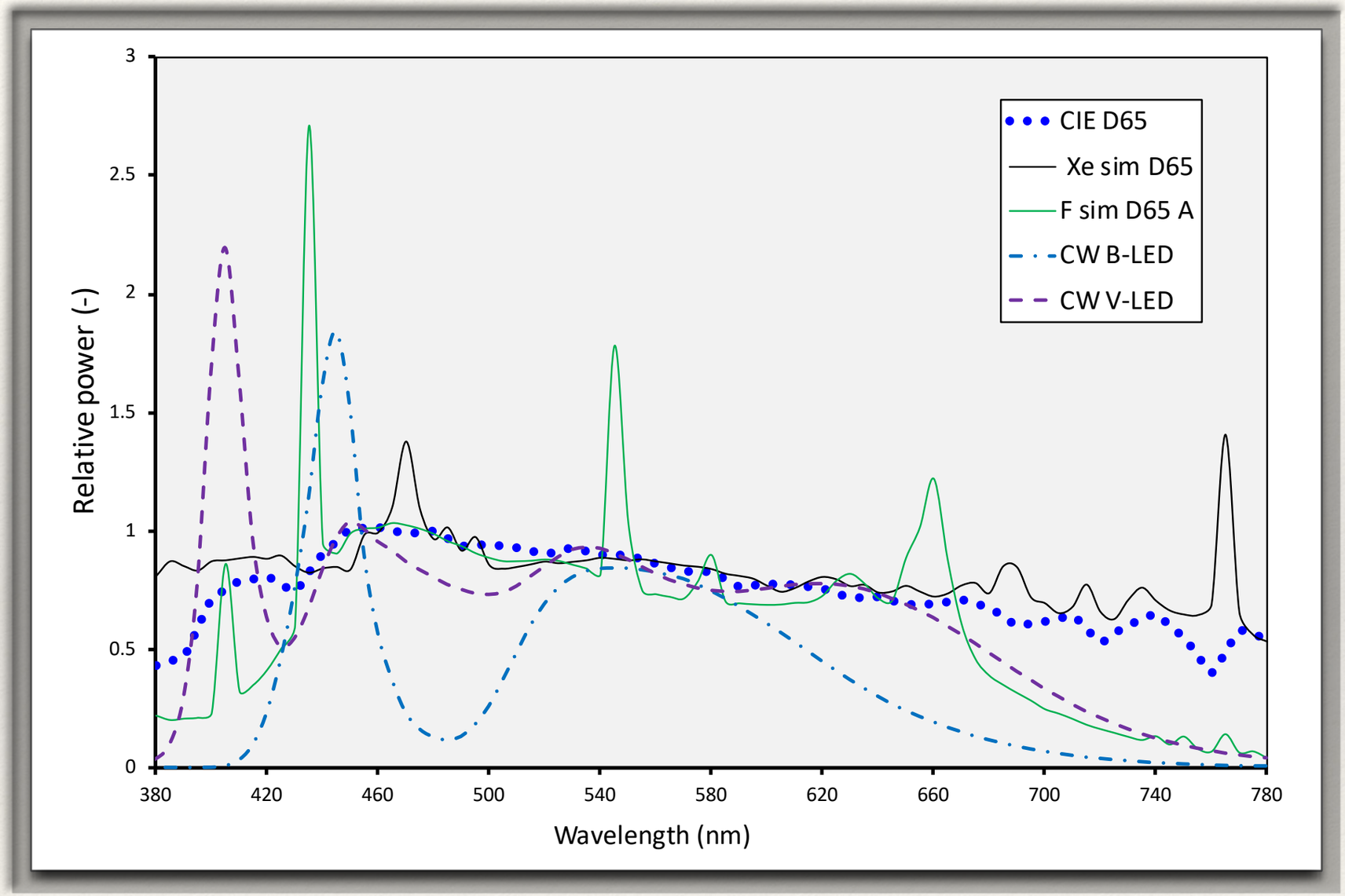
MiniScan XE (45°a:0°)



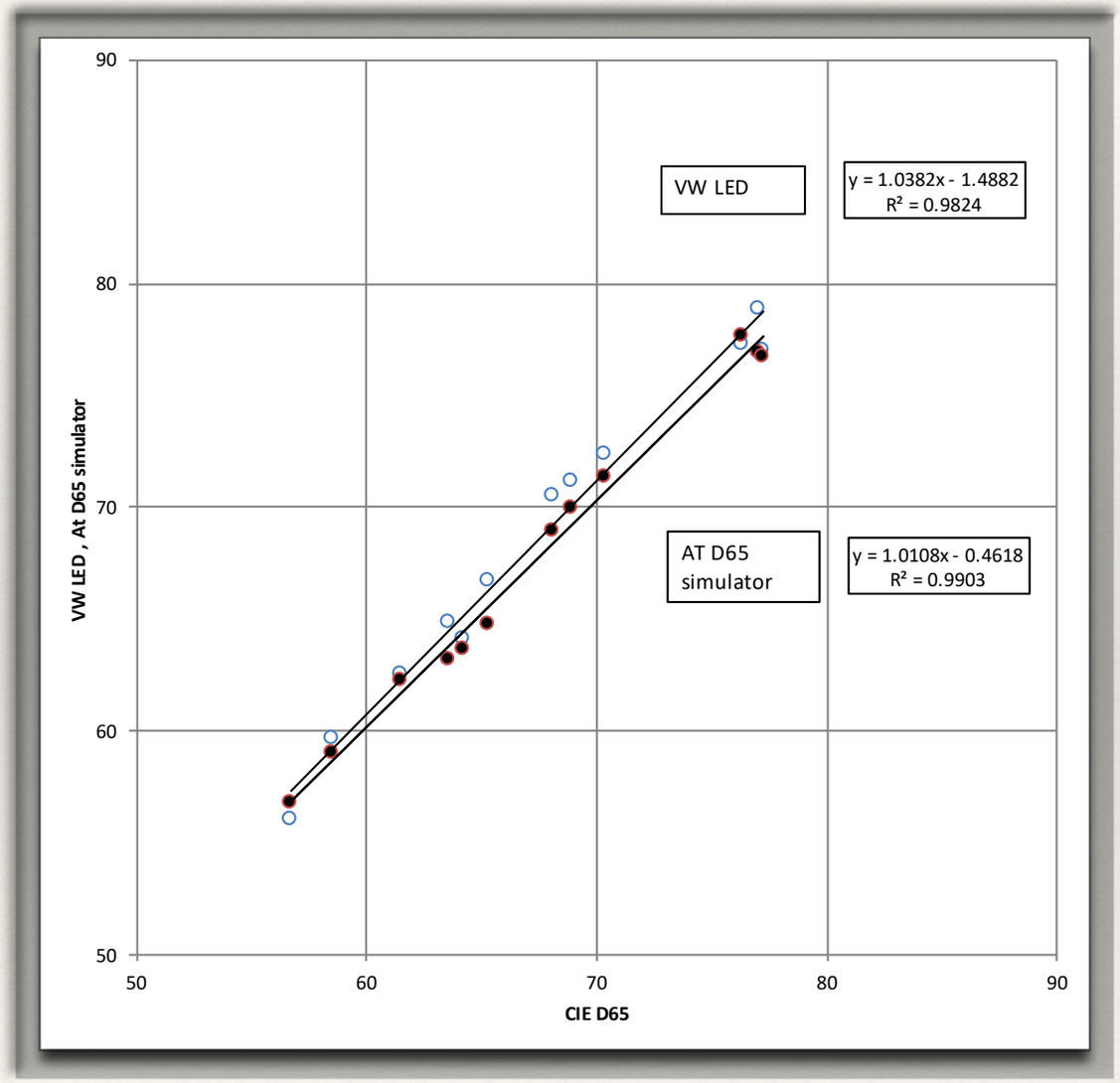


LabScan XE (0°:45°a)

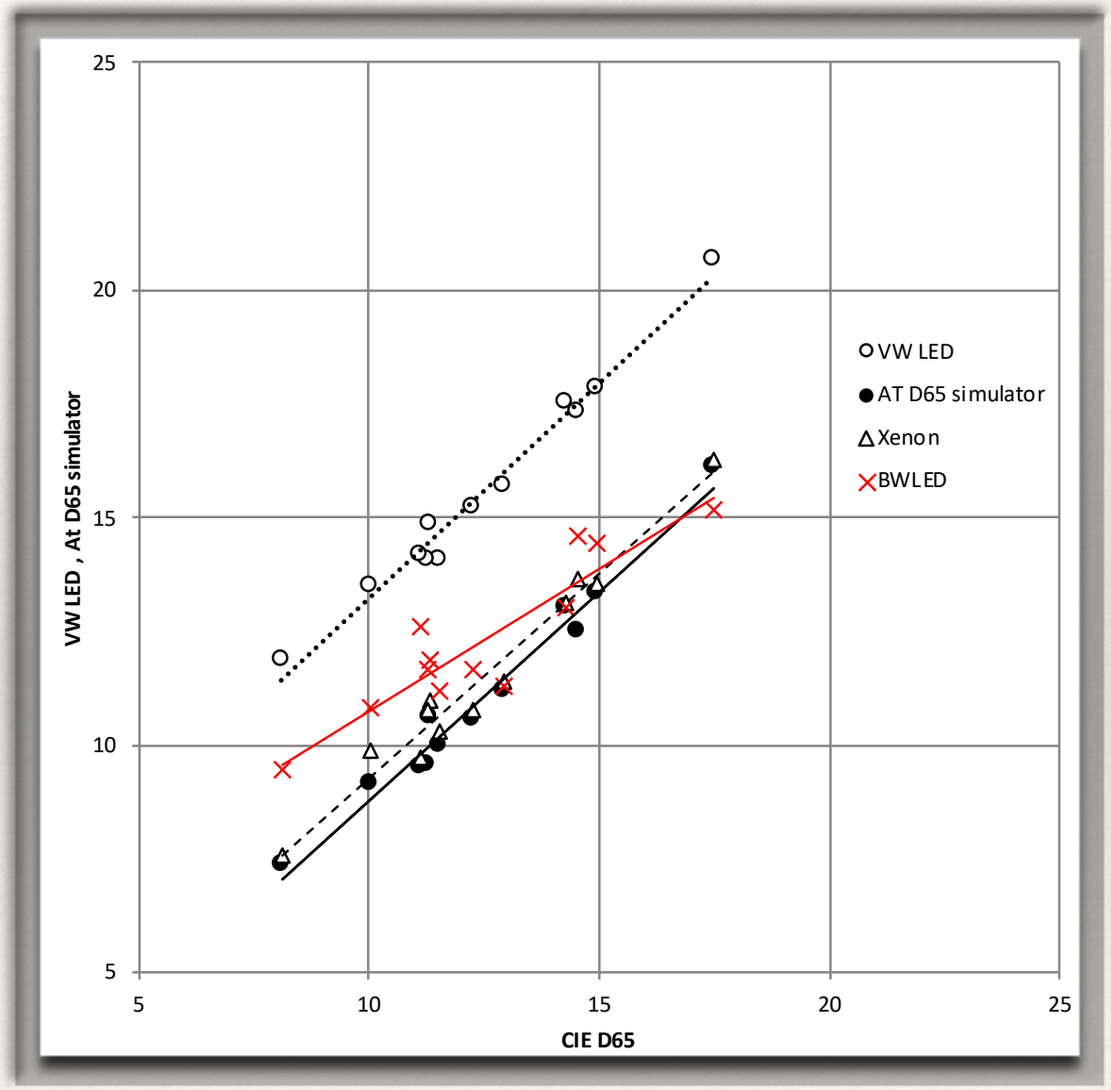
Light source problem



Rd, +b data comparison



Rd



+b

Aperture reading problem I

Aperture reading problem II

Colorimetric Calculations

$$X = 0.412453R + 0.357580G + 0.180423B$$

$$Y = 0.212671R + 0.715160G + 0.072169B$$

$$Z = 0.019334R + 0.119193G + 0.950227B$$

Images in RGB space can be converted into the CIE *L*a*b** space with the help of the following conversion equations:

$$L^* = 116\left[f\left(\frac{Y}{Yn}\right) - 16\right]$$

$$a^* = 500\left[f\left(\frac{X}{Xn}\right) - f\left(\frac{Y}{Yn}\right)\right] \qquad a_{rd} = 1.75 f_y(1.02X - Y)$$

$$b^* = 200\left[f\left(\frac{Y}{Yn}\right) - f\left(\frac{Z}{Zn}\right)\right] \qquad b_{rd} = .70 f_y(Y - .847Z)$$

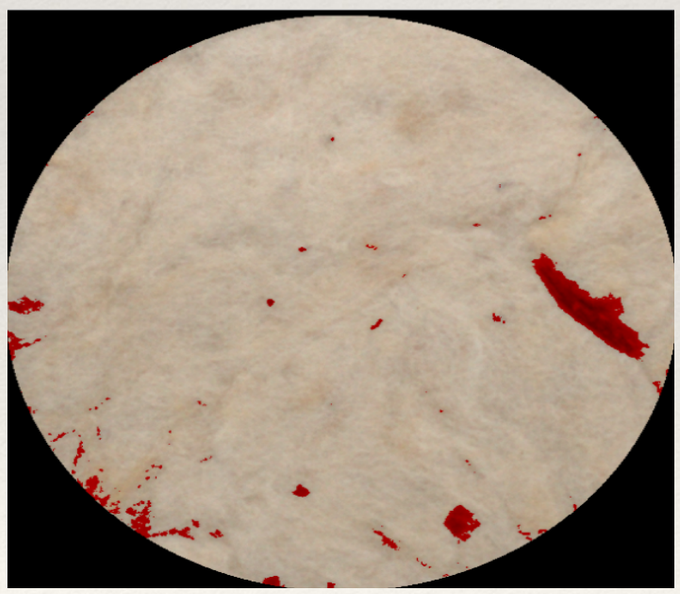
(Xn, Yn, Zn) are the (X, Y, Z) values for the reference white point.

$$C = \sqrt{a^2 + b^2}$$

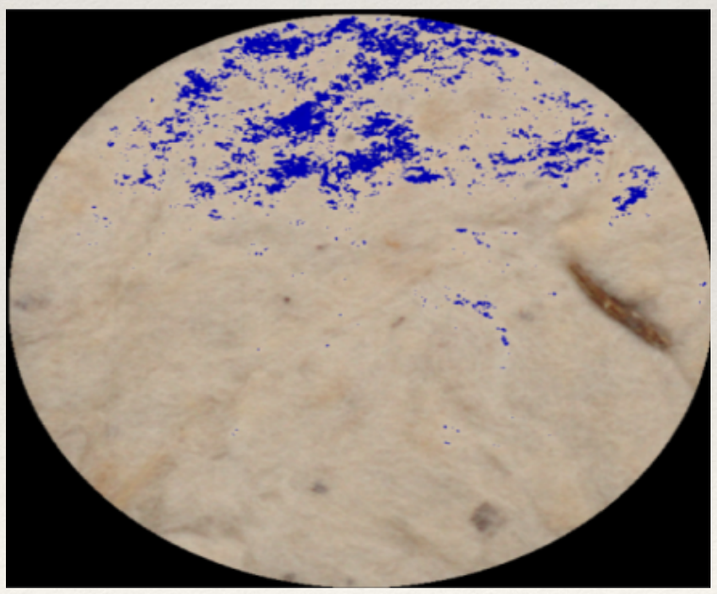
$$H = tan^{-1}\left(\frac{b}{a}\right)$$

Threshold problem - L^*

Sample image

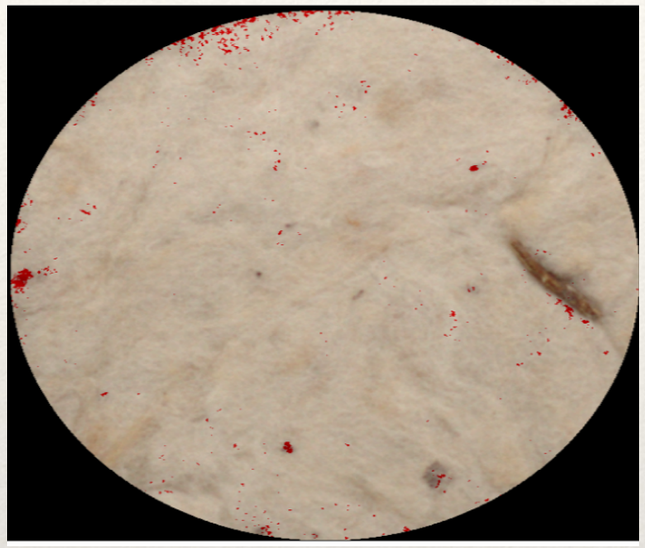


LCH (L < Lth)

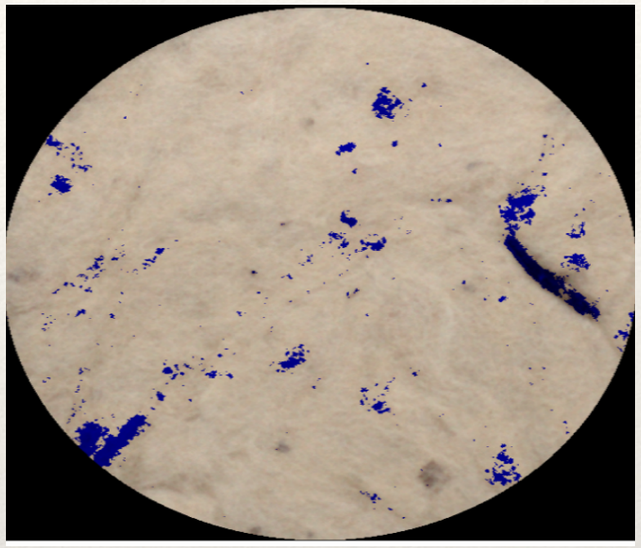


LCH (L > Lth)

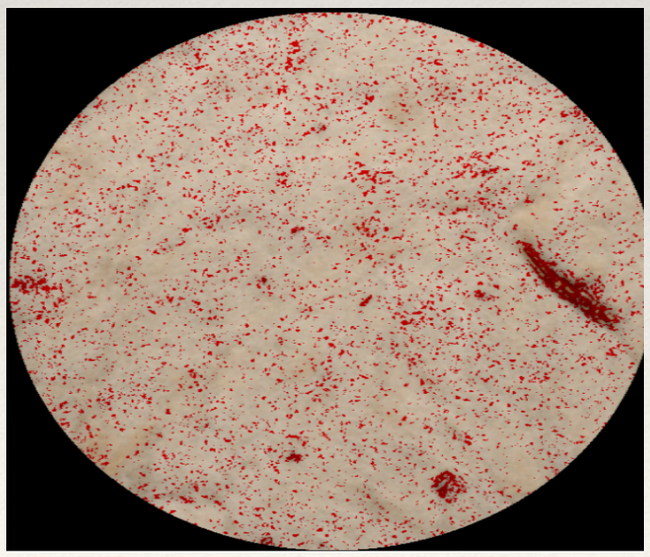
Threshold problem - C* and h°



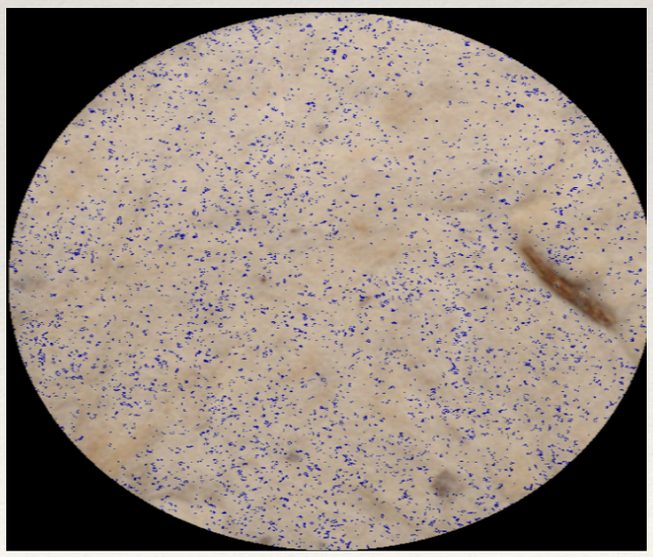
LCH (C < Cth)



LCH (C > Cth)

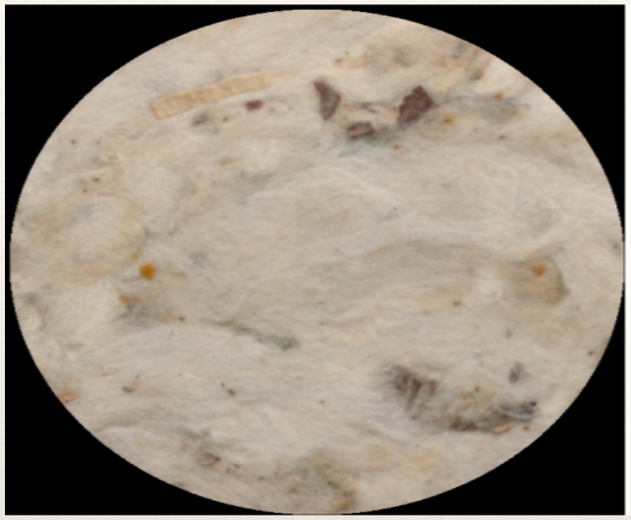


LCH (H < Hth)

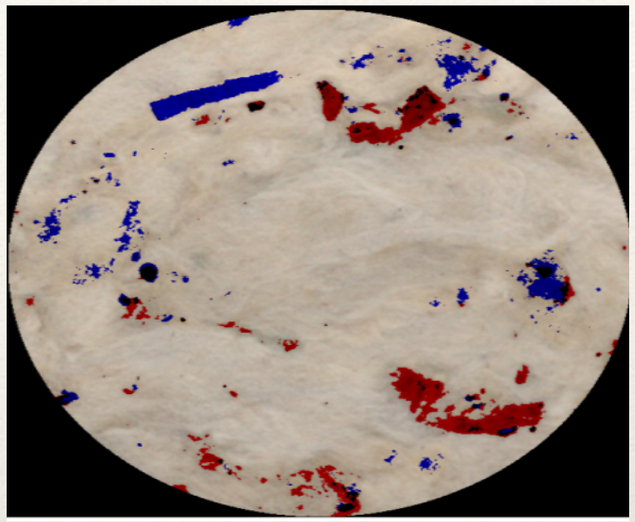


LCH (H > Hth)

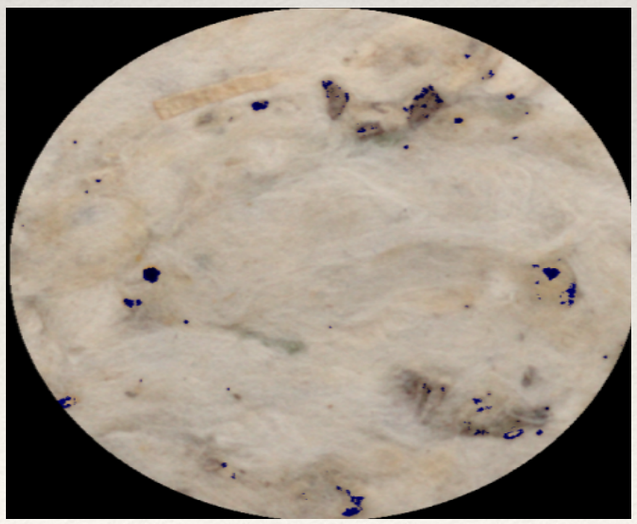
Combined Threshold:“AND” or “OR”?



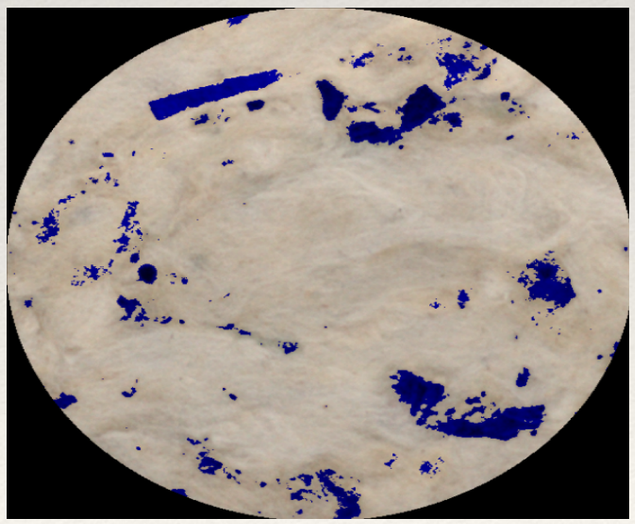
Sample image



Two independent thresholds: (L < Lth) (C > Cth)

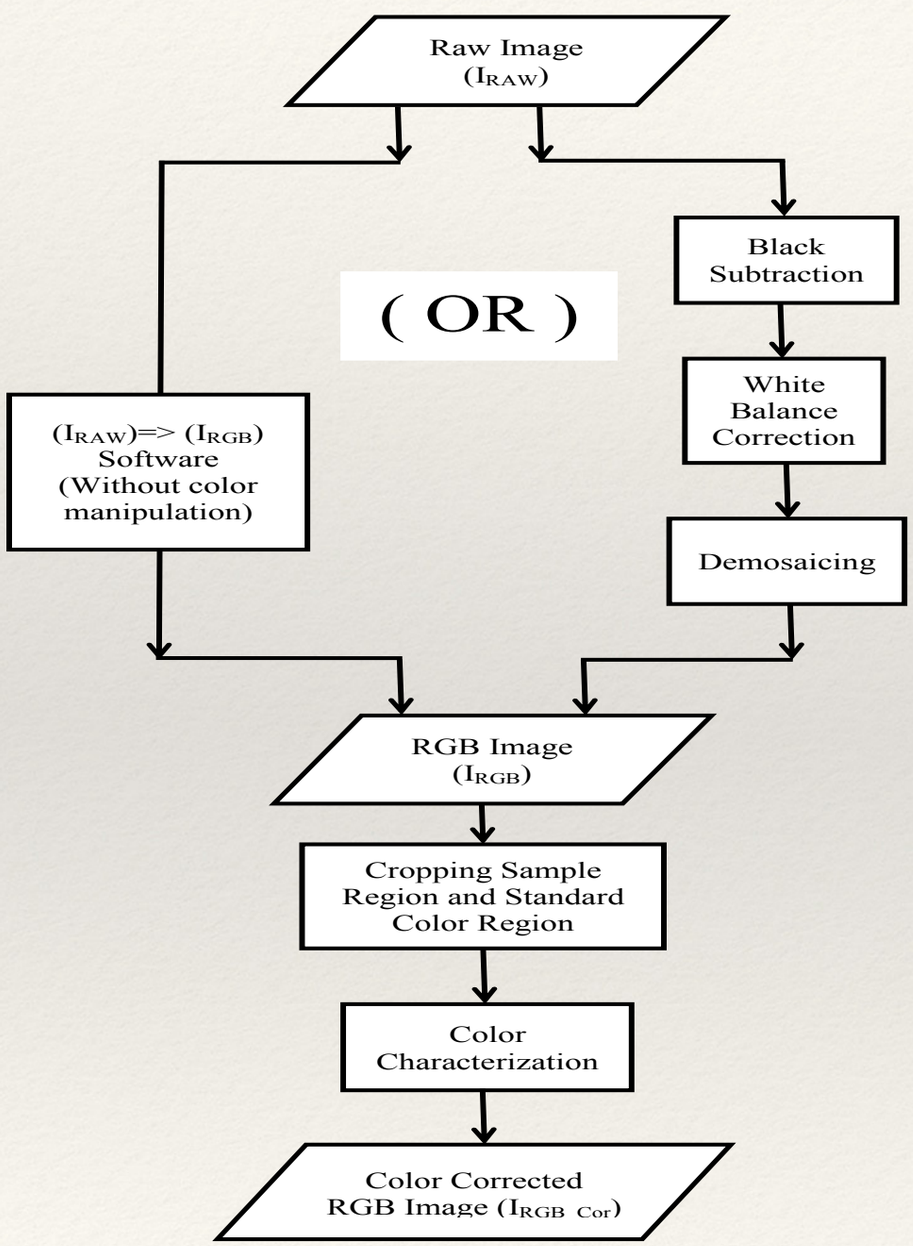


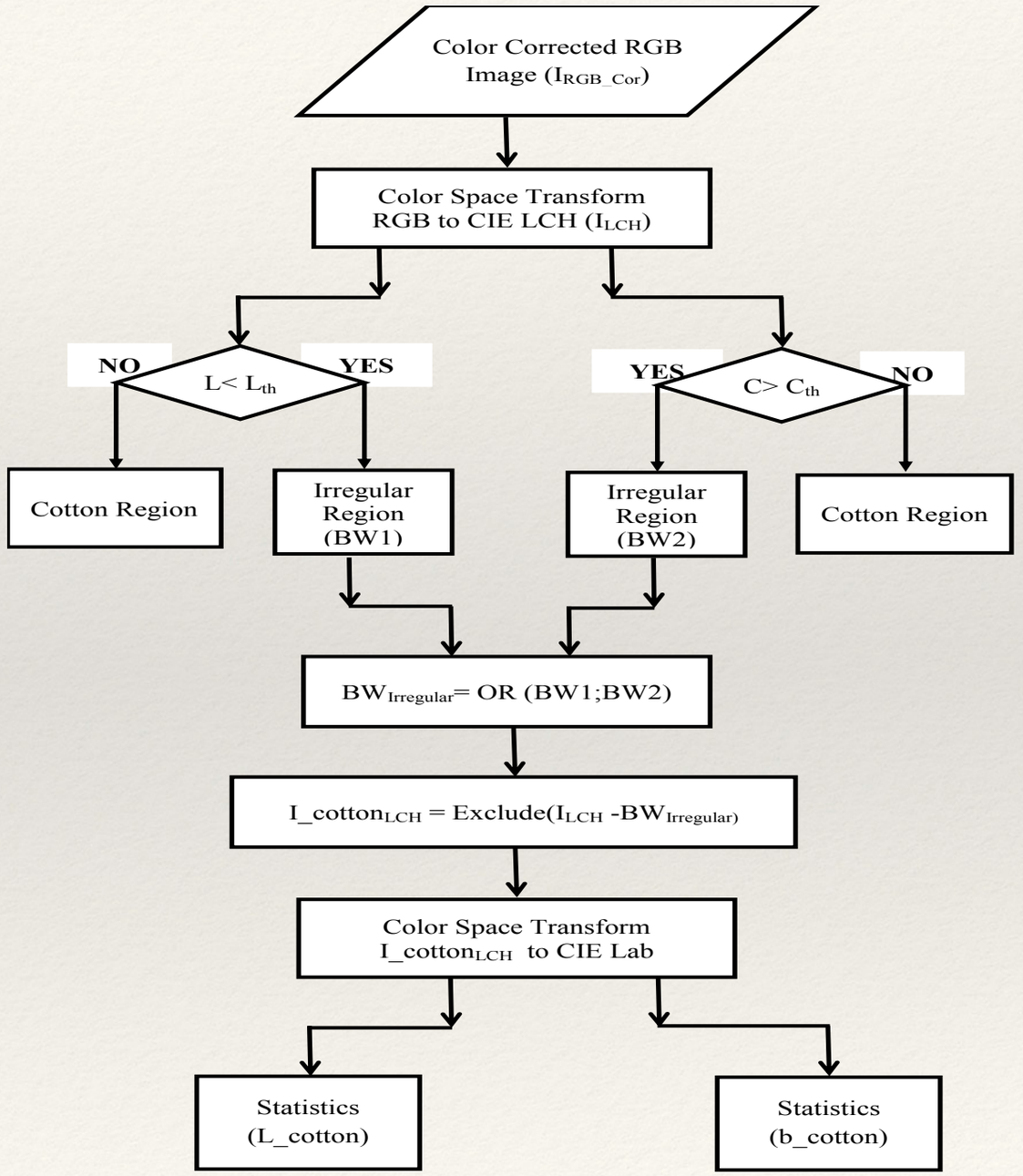
(L < Lth) AND (C > Cth)



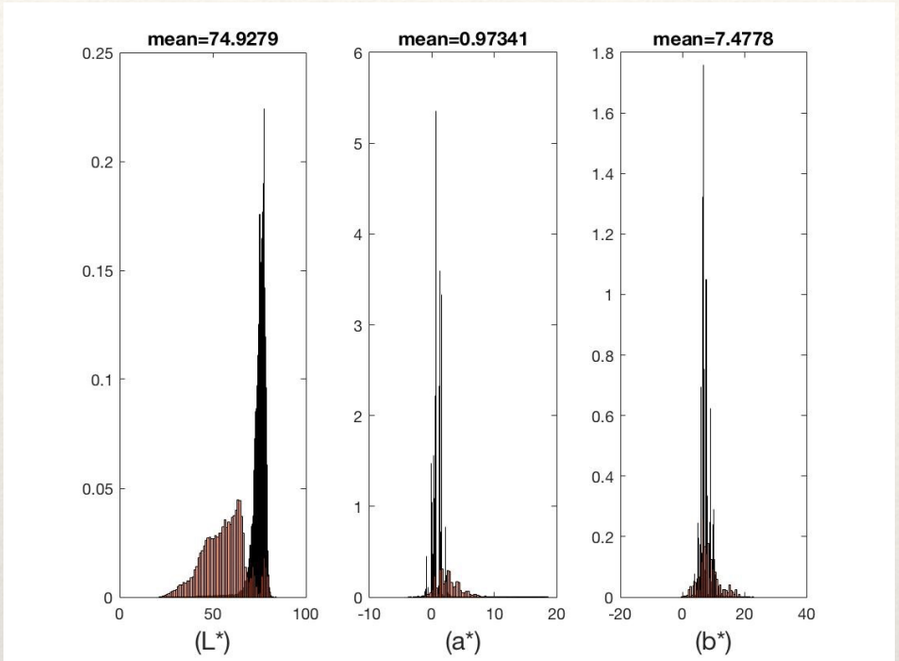
L < Lth) OR (C > Cth)

Block Scheme for Trash Segmentation



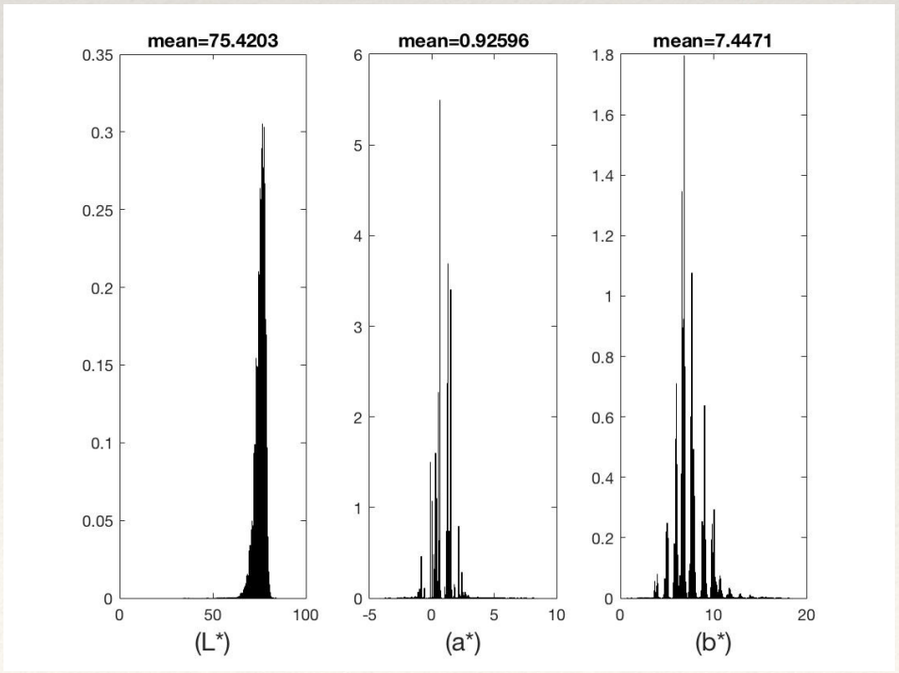


Relative histogram of L*a*b*

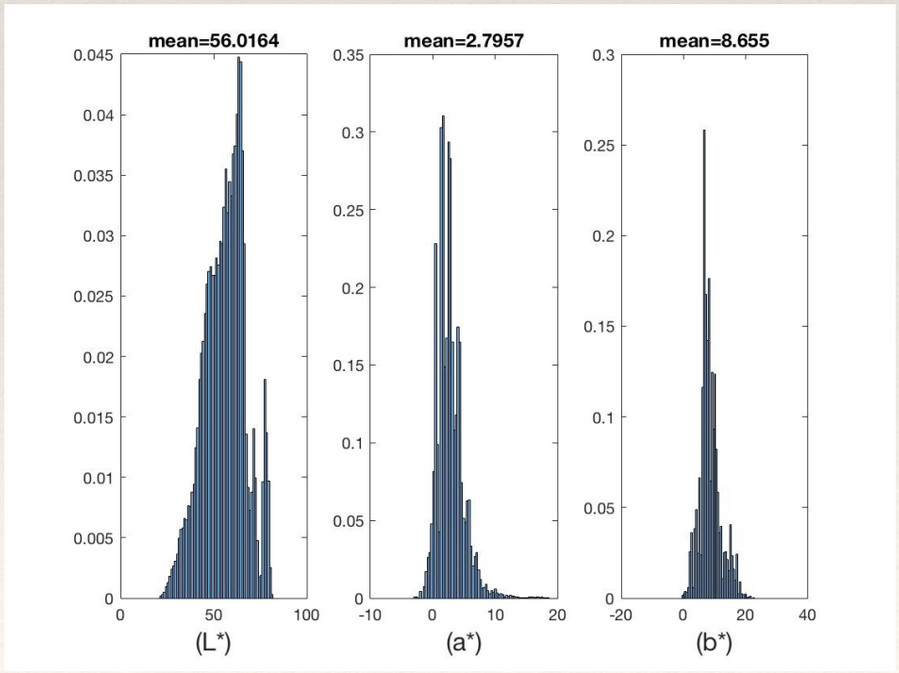


L* = 74.93
a*= 0.97
b* = 7.48

Difference between non-segmented reading and segmented reading is related to ration of threshold particles in evaluated sample.

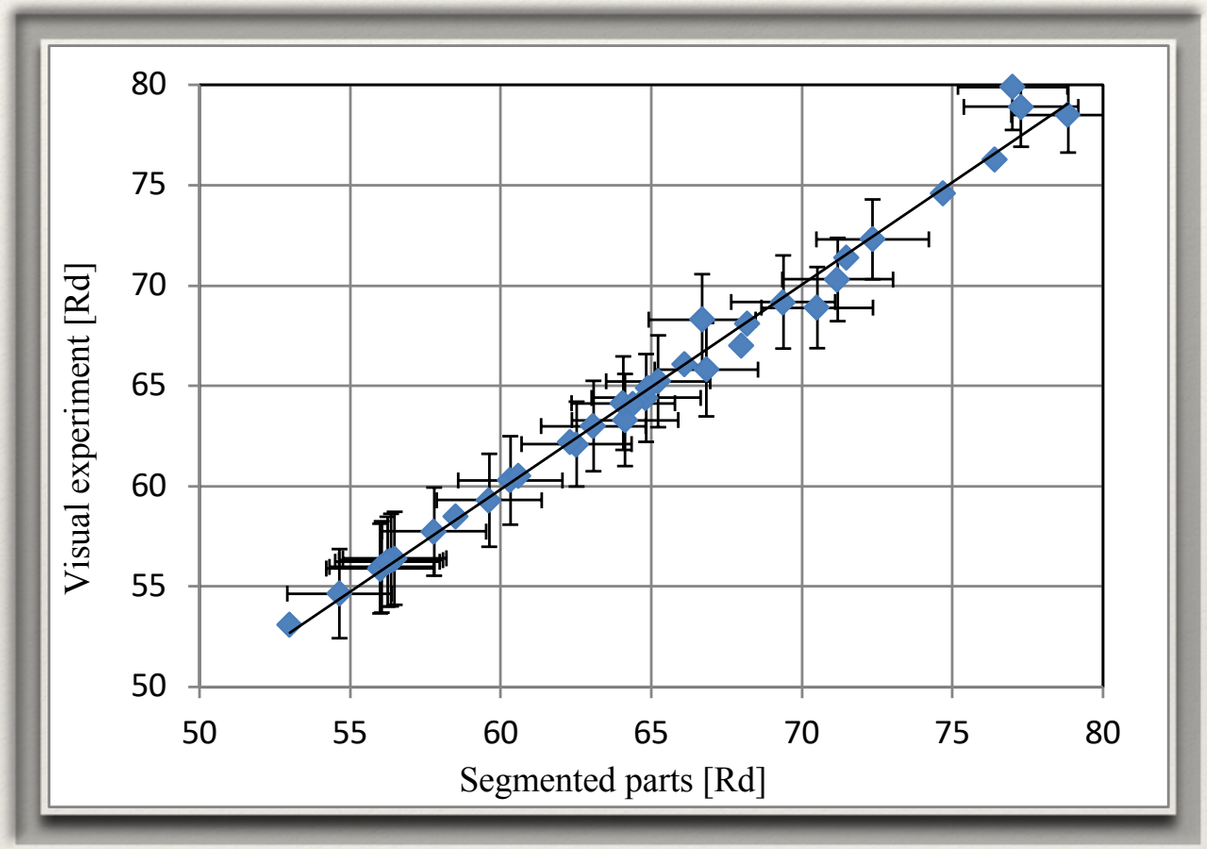


L* = 75.42
a*= 0.93
b* = 7.45

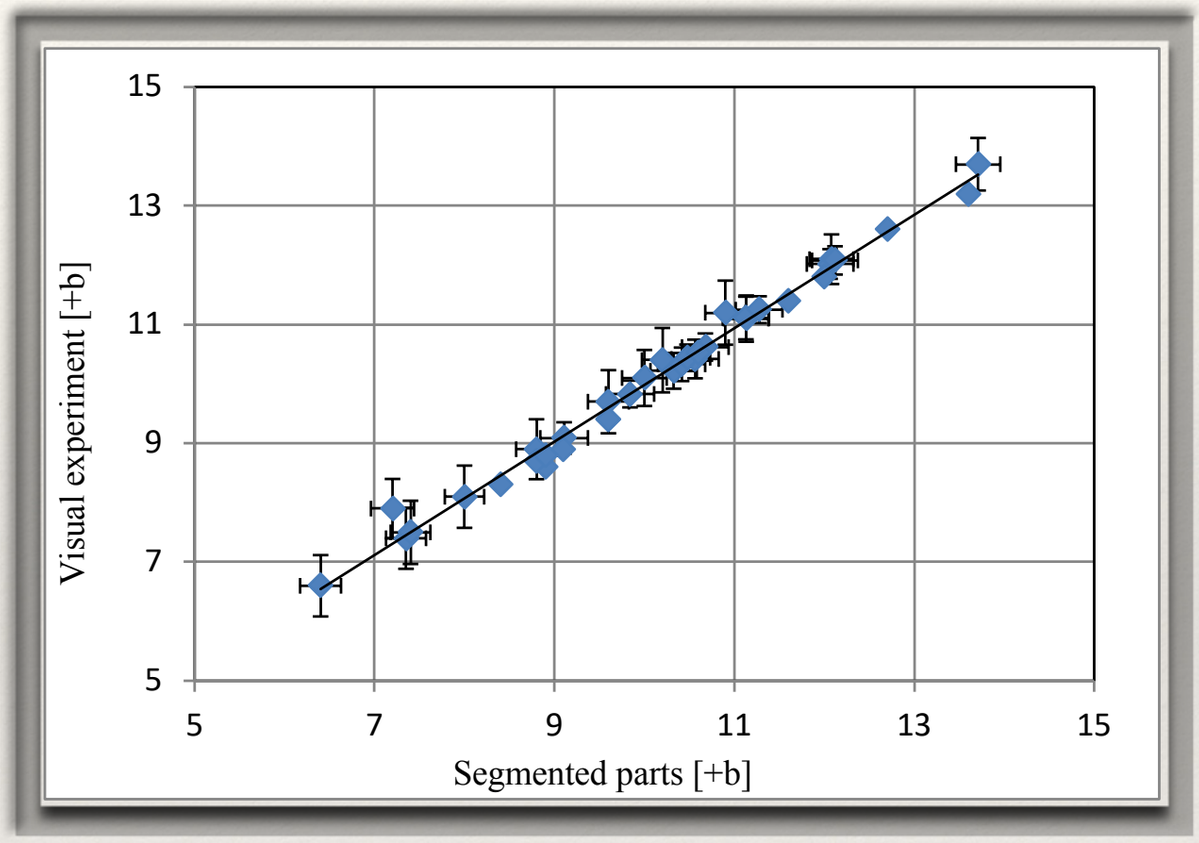


L* = 56.02
a*= 2.80
b* = 8.66

Visual assesment vs segmentation



Rd



+b

Conclusion

- Full spectrum LEDs are suitable for measurement and assessment of cotton samples if CCT is near 6500 K.
- Due to problem with Helmholtz reciprocity of cotton samples is preferable 45°:0° viewing geometry.
- Multiple reading with rotation reduce noise and resulting uncertainty.
- Segmentation method can be effectively used to determine the color variation in a cotton sample.