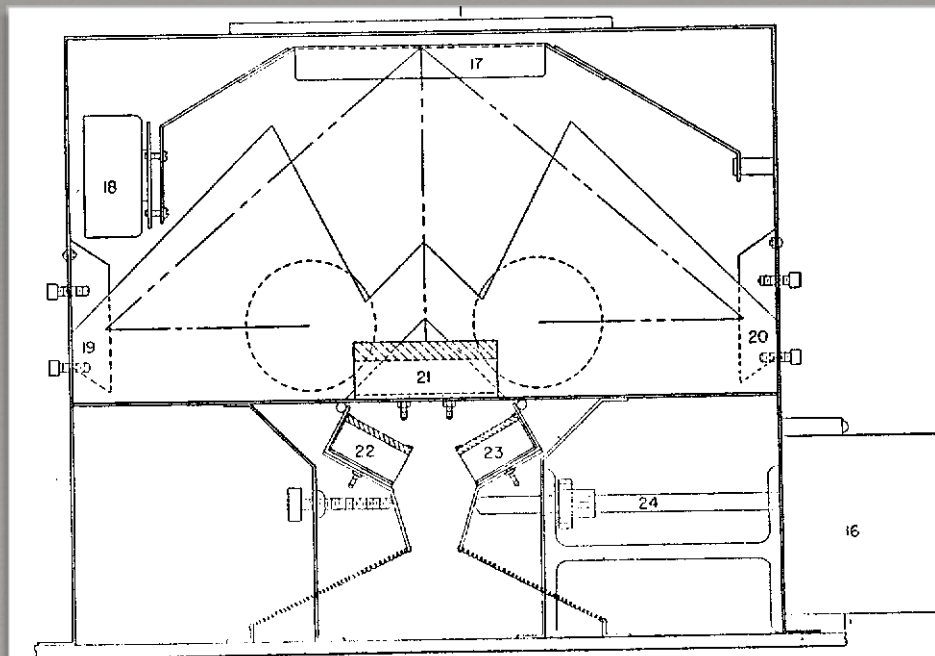




Application of segmentation method for cotton trash and color measurement

*Vik, M., Viková, M.,
Yildirim, B., Khan, N.*

Cotton grading

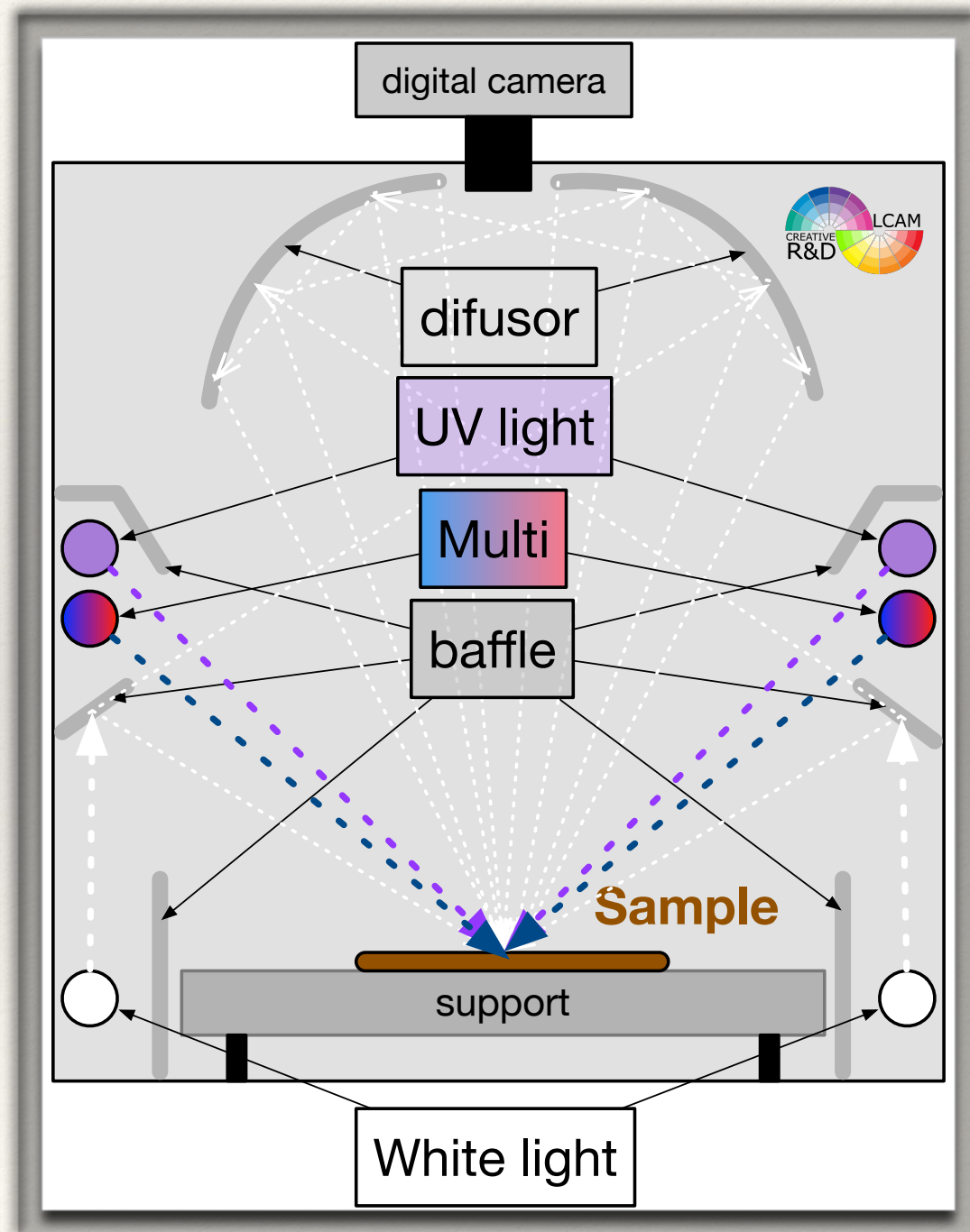


for American Upland Cotton

3	SM	11-1	11-2	11-3	11-4	12-1	12-2	13-1	13-2	13-3	13-4	24-1	24-2	24-3	24-4	25-1	25-2	25-3	25-4	25-5
4	SLM	21-1	21-2	21-3	21-4	22-1	22-2	23-1	23-2	23-3	23-4	34-1	34-2	34-3	34-4	35-1	35-2	35-3	35-4	35-5
5	LM	31-1	31-2	31-3	31-4	32-1	32-2	33-1	33-2	33-3	33-4	44-1	44-2	44-3	44-4	45-1	45-2	45-3	45-4	45-5
6	SGO	41-1	41-2	41-3	41-4	42-1	42-2	43-1	43-2	43-3	43-4	54-1	54-2	54-3	54-4	55-1	55-2	55-3	55-4	55-5
7	GO	51-1	51-2	51-3	51-4	52-1	52-2	53-1	53-2	53-3	53-4	64-1	64-2	64-3	64-4	65-1	65-2	65-3	65-4	65-5
		61-1	61-2	61-3	61-4	62-1	62-2	63-1	63-2	63-3	63-4	74-1	74-2	74-3	74-4	75-1	75-2	75-3	75-4	75-5
		71-1	71-2	71-3	71-4	82-1	82-2	83-1	83-2	83-3	83-4	94-1	94-2	94-3	94-4	95-1	95-2	95-3	95-4	95-5
		81-1	81-2	81-3	81-4	92-1	92-2	93-1	93-2	93-3	93-4	104-1	104-2	104-3	104-4	105-1	105-2	105-3	105-4	105-5

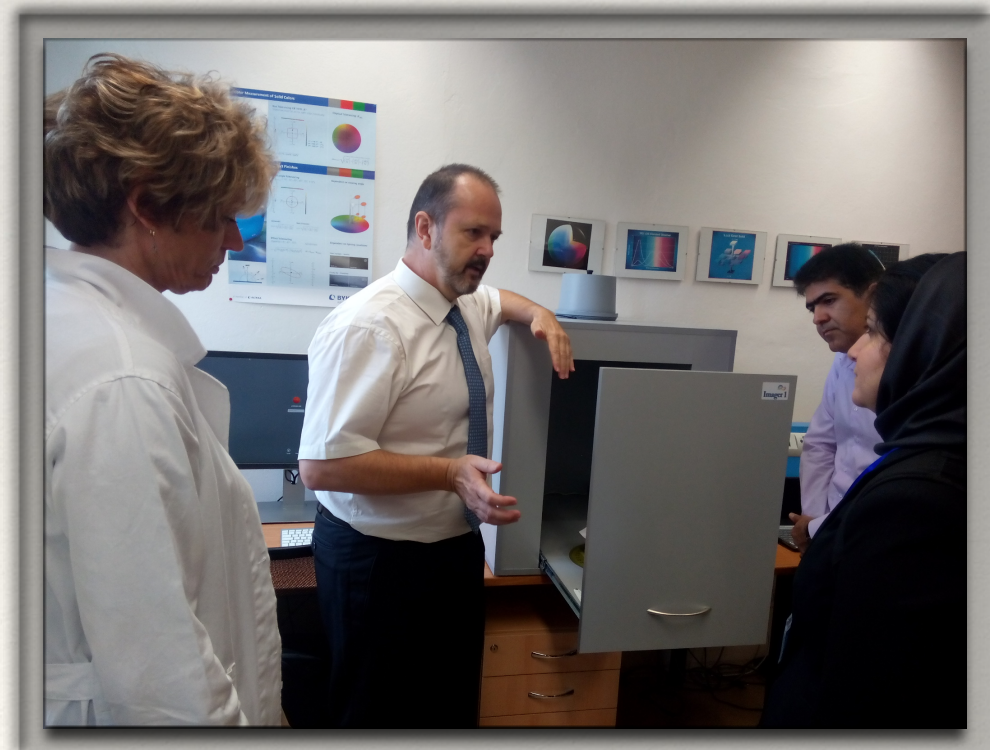
USDA - AMS

LCAM Imager

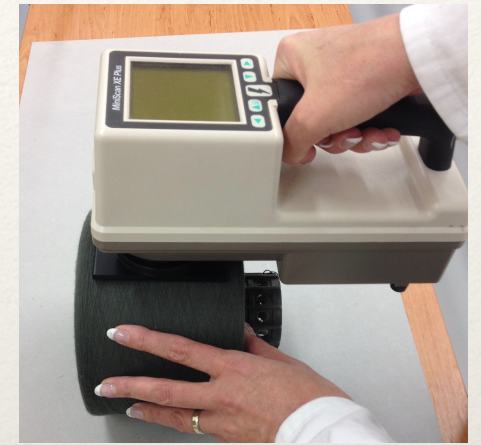
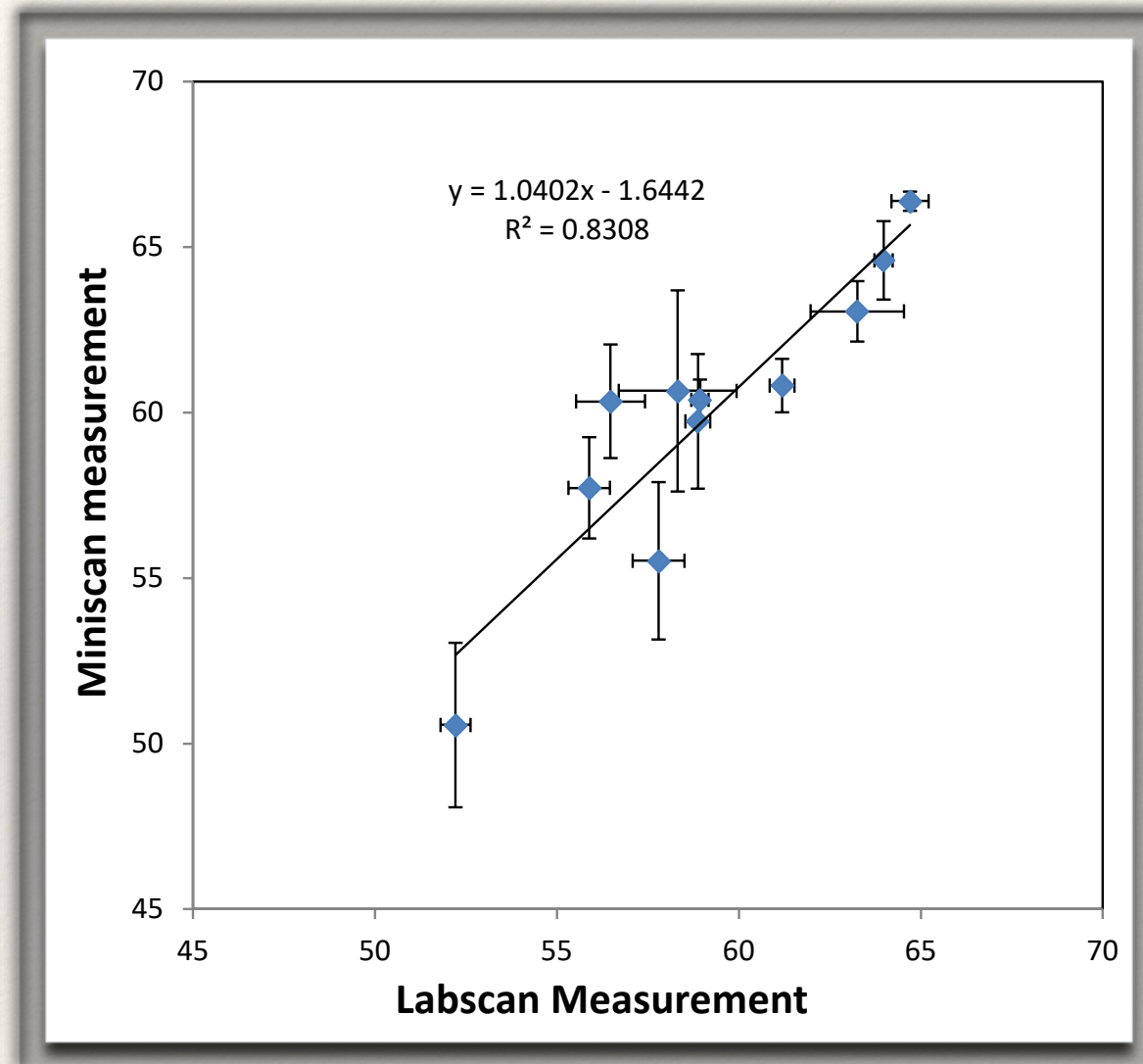
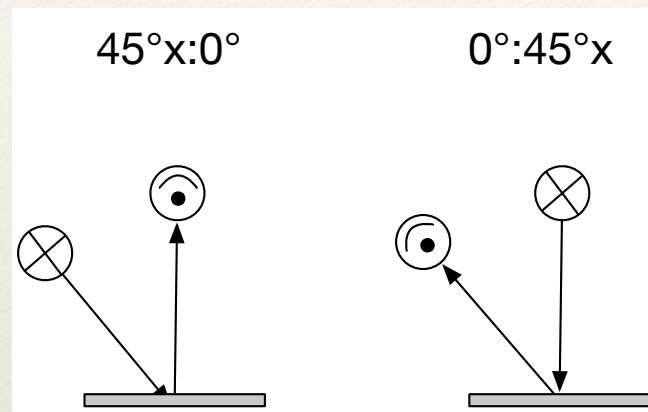


Multispectral Imaging System

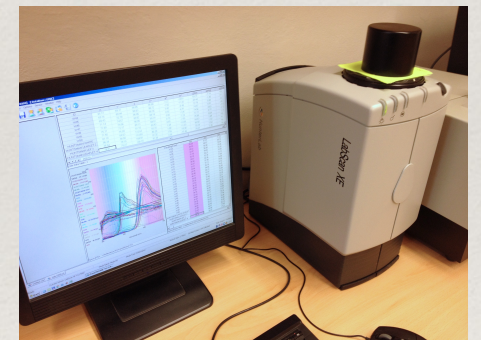
- ❖ 6000 x 4000 px
- ❖ 18 chanelns
- ❖ replaceable daylight simulator
- ❖ support with 360° table



Helmholtz reciprocity?

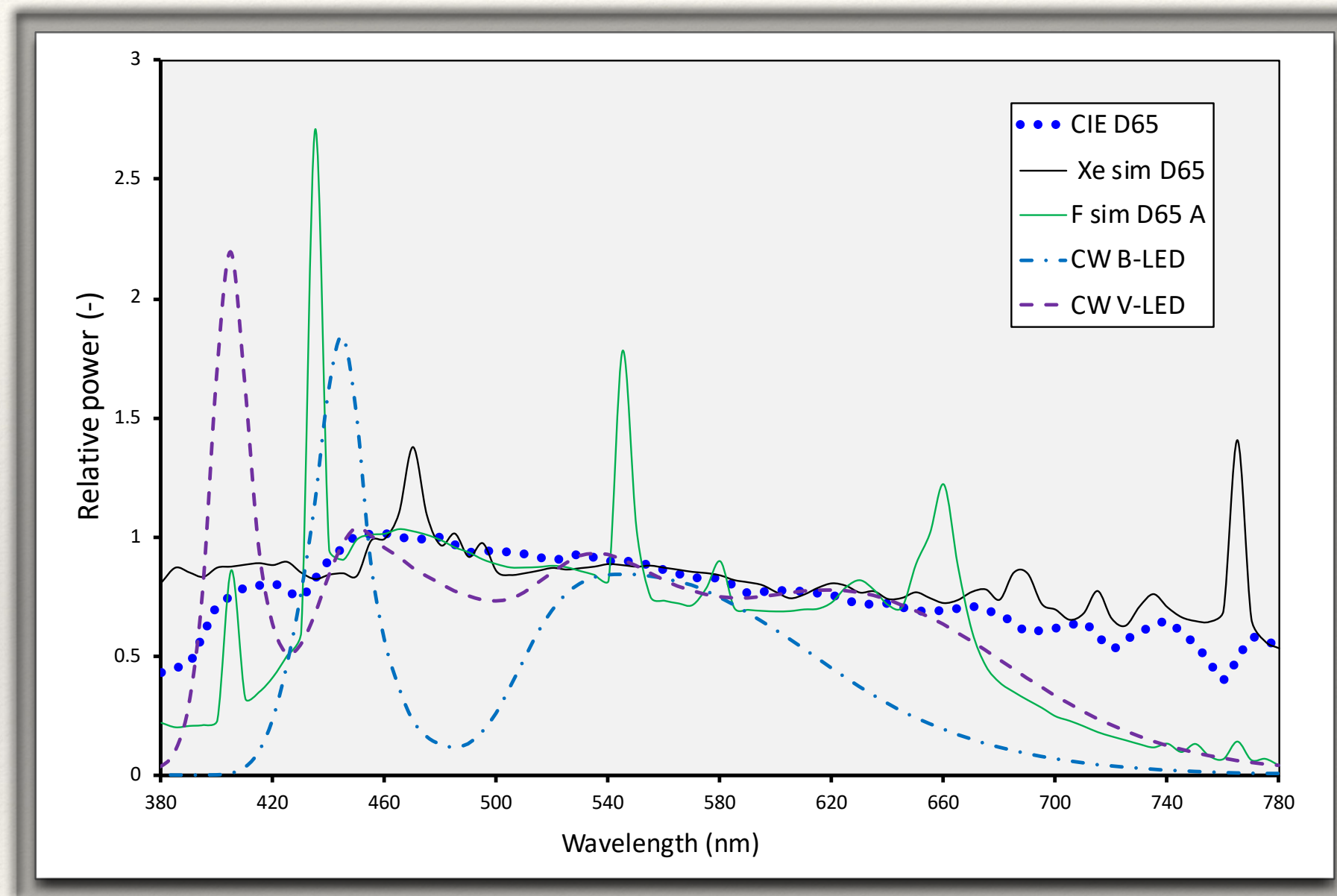


MiniScan XE (45°a:0°)

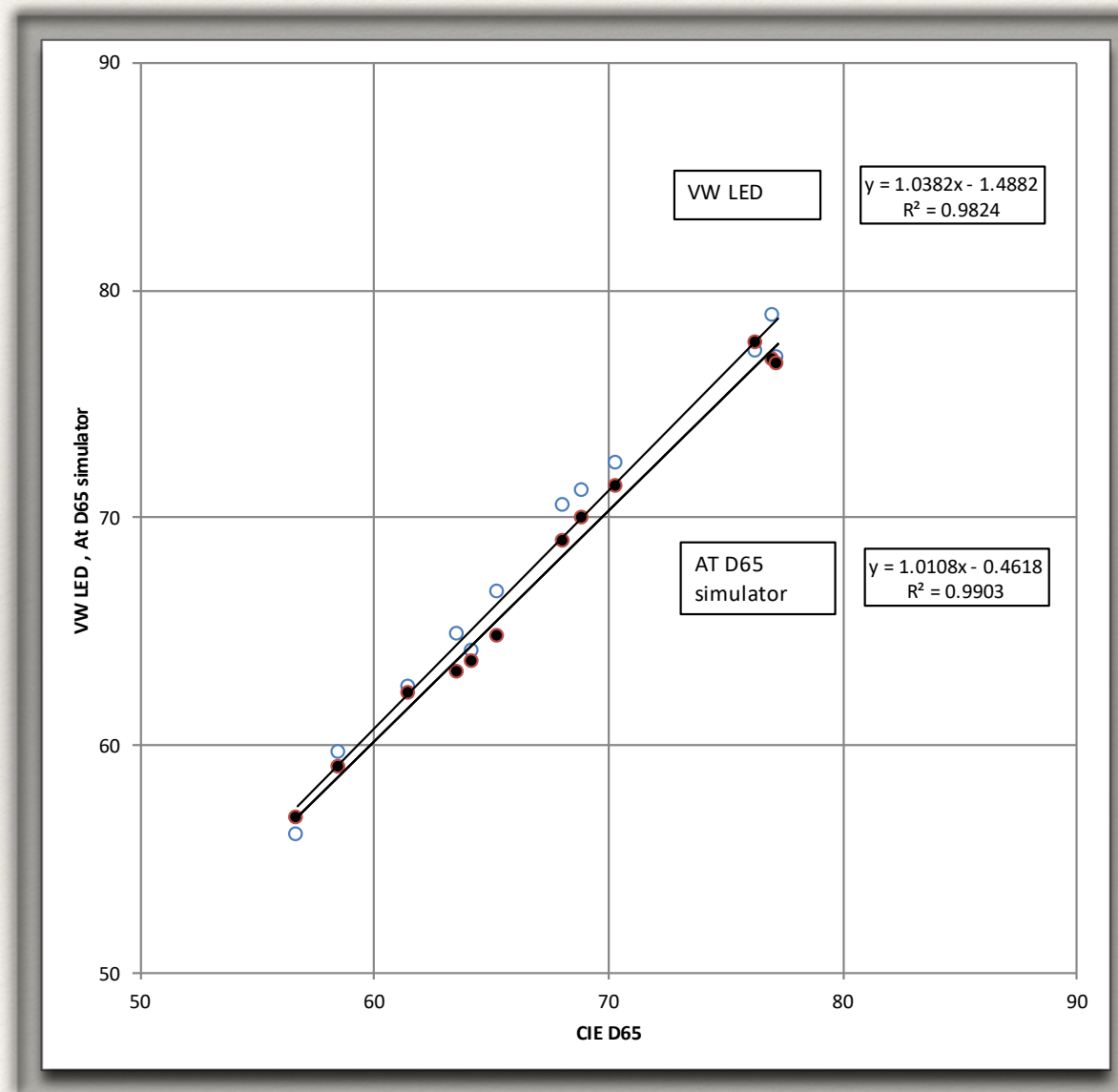


LabScan XE (0°:45°a)

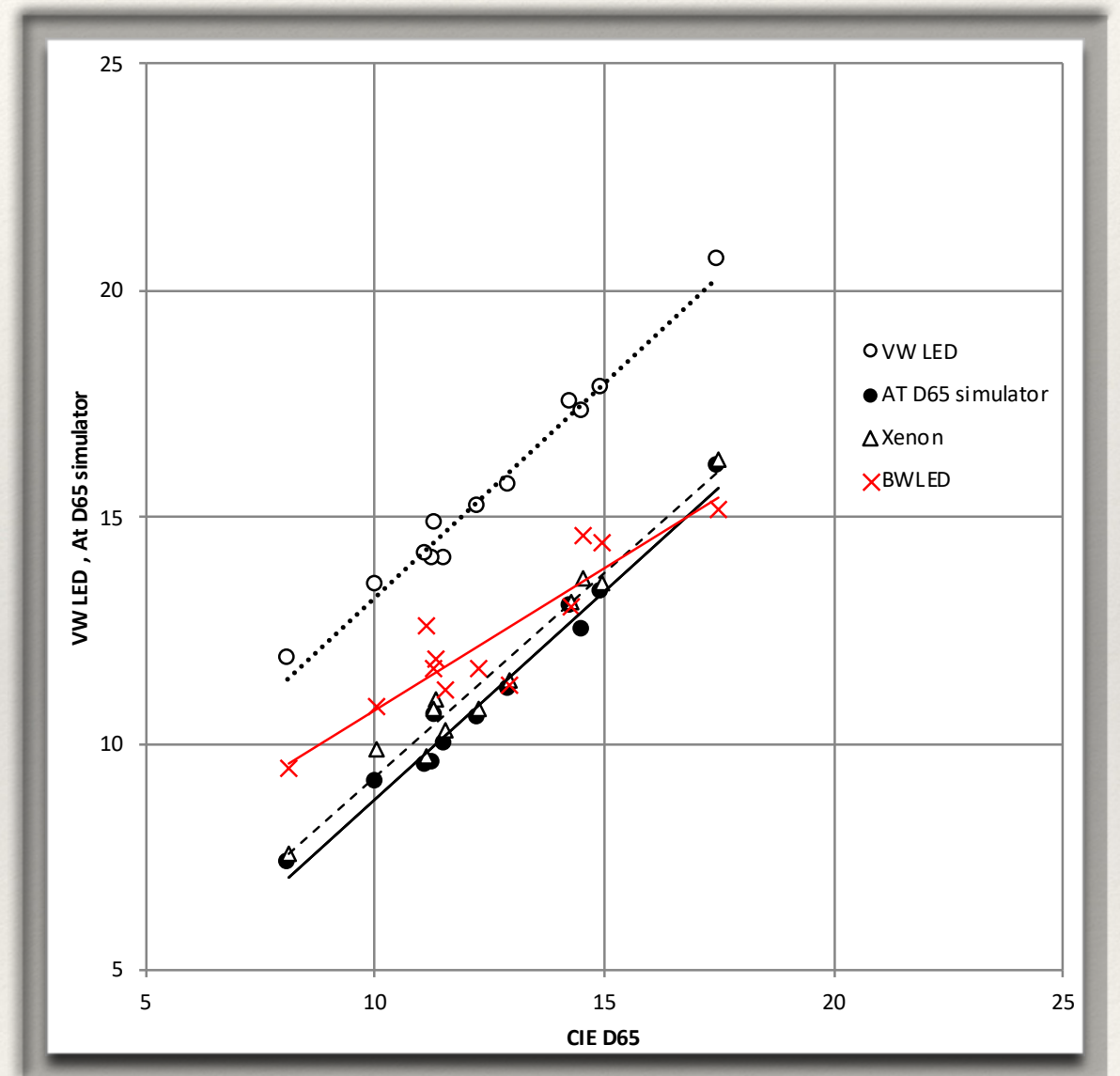
Light source problem



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:

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

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

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

(X_n , Y_n , Z_n) are the (X, Y, Z) values for the reference white point.

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

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

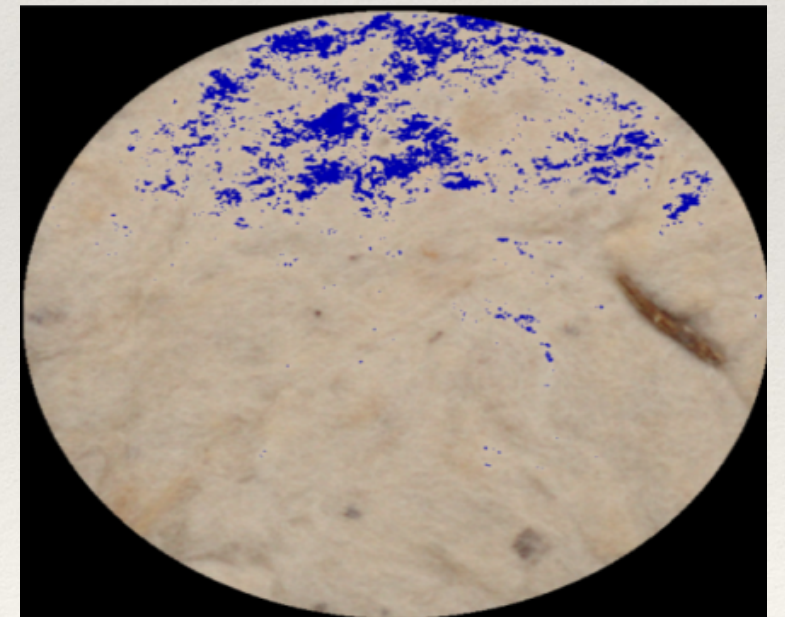
Threshold problem - L^*



Sample image

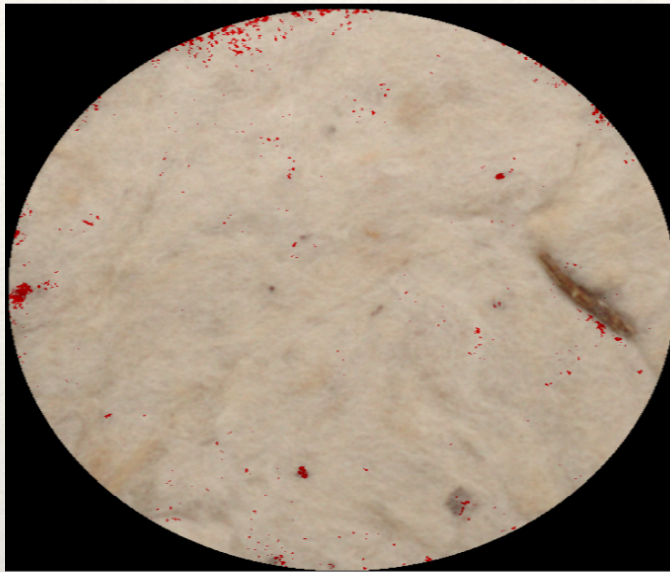


LCH ($L < L_{th}$)

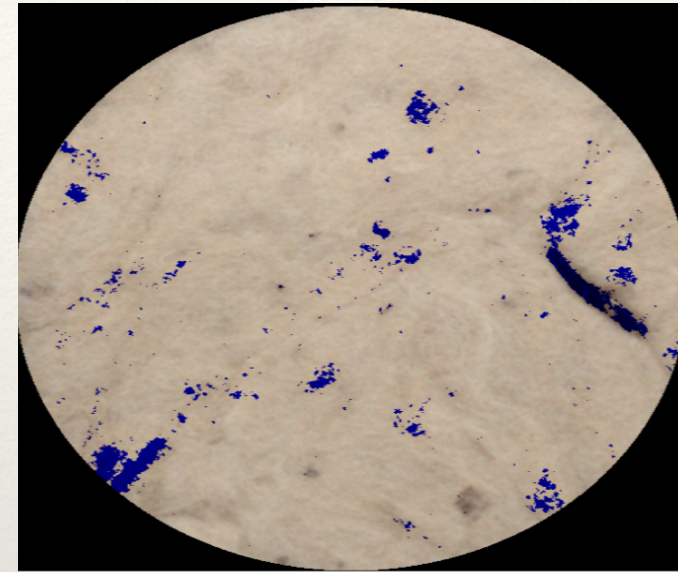


LCH ($L > L_{th}$)

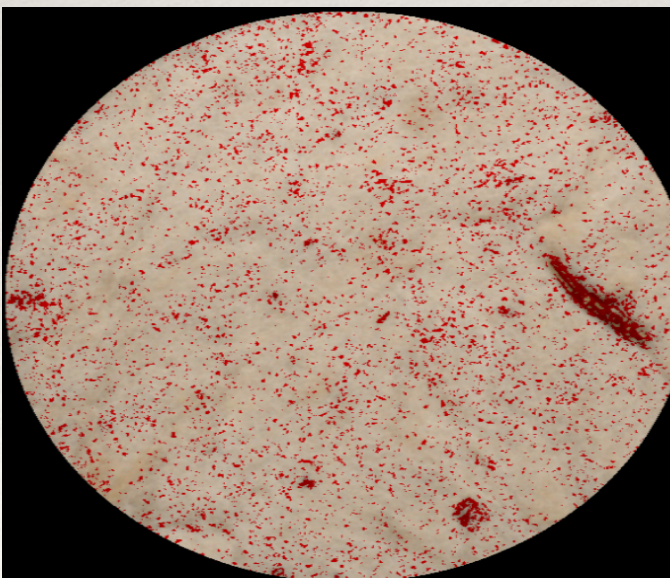
Threshold problem - C^* and h°



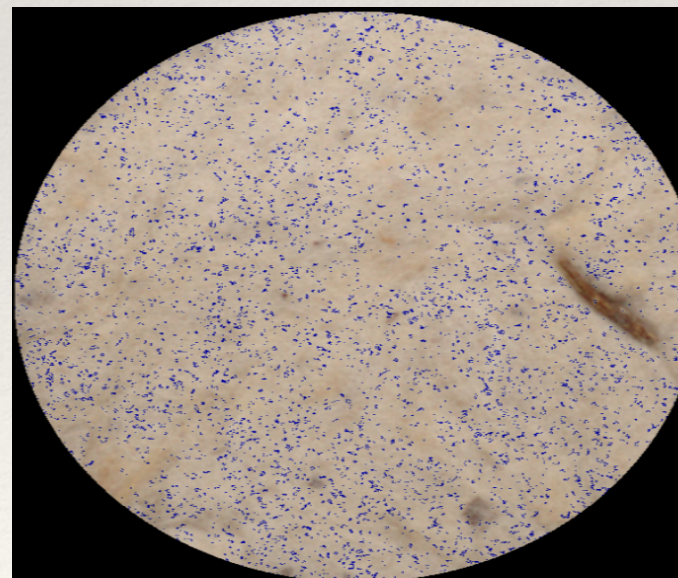
LCH ($C < C_{th}$)



LCH ($C > C_{th}$)



LCH ($H < H_{th}$)

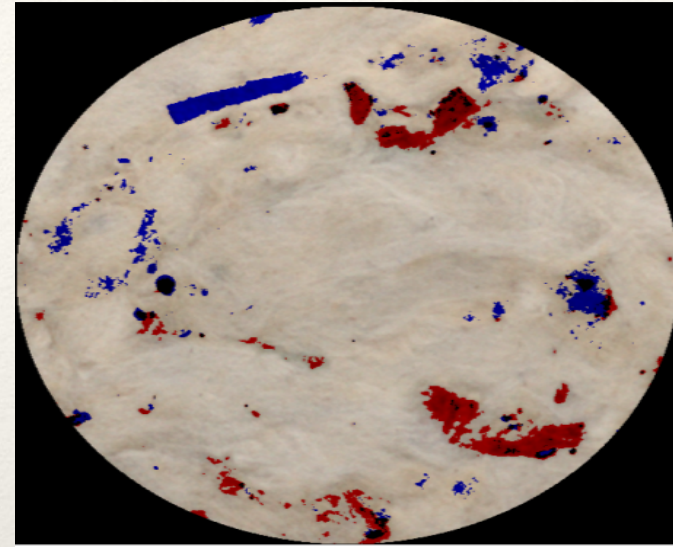


LCH ($H > H_{th}$)

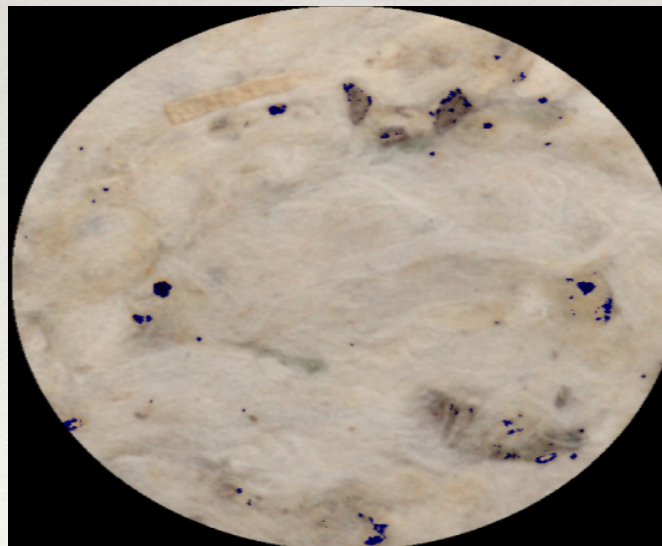
Combined Threshold: “AND” or “OR”?



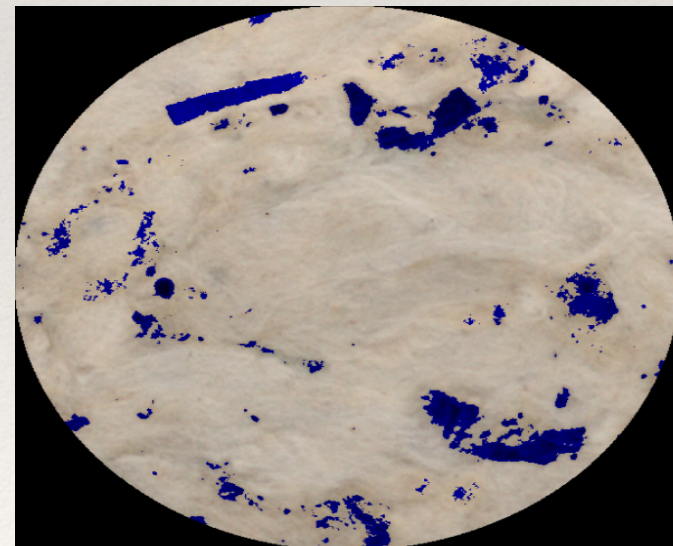
Sample image



Two independent thresholds: $(L < L_{th})$ $(C > C_{th})$

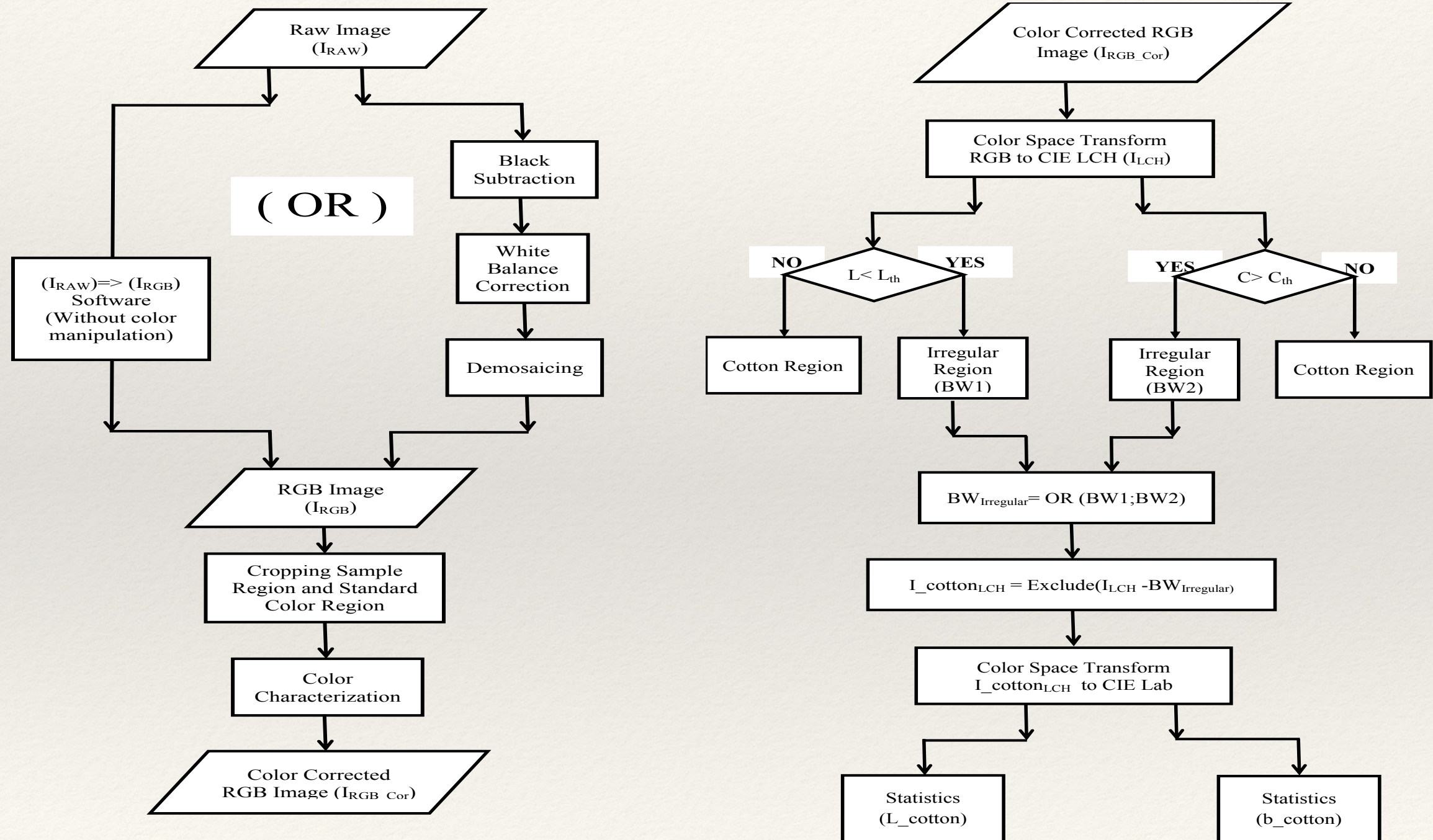


$(L < L_{th})$ AND $(C > C_{th})$

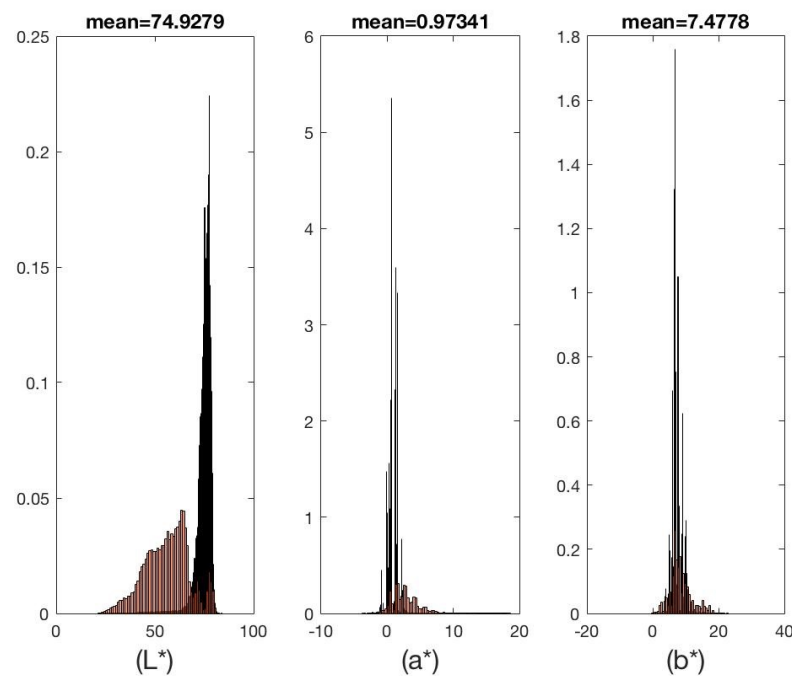


$(L < L_{th})$ OR $(C > C_{th})$

Block Scheme for Trash Segmentation

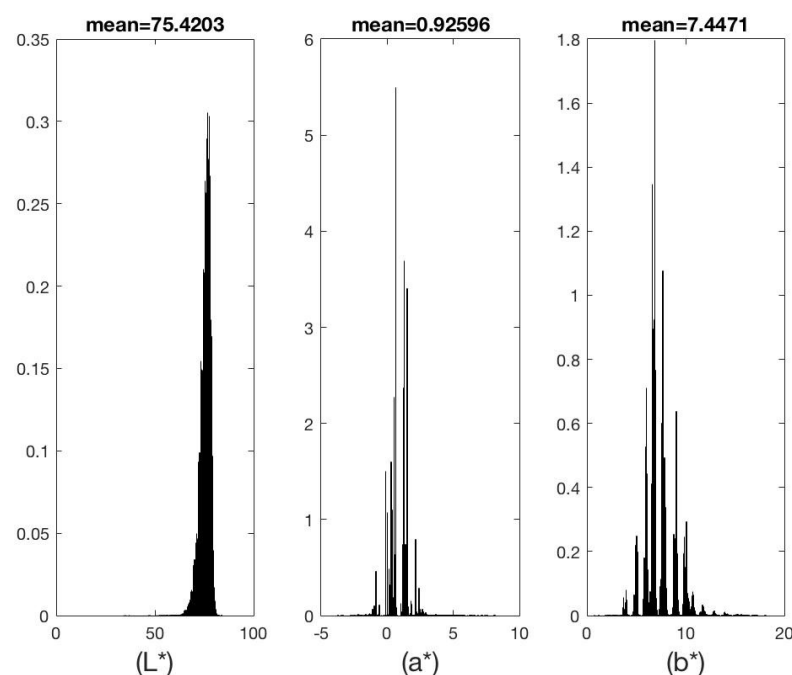


Relative histogram of $L^*a^*b^*$

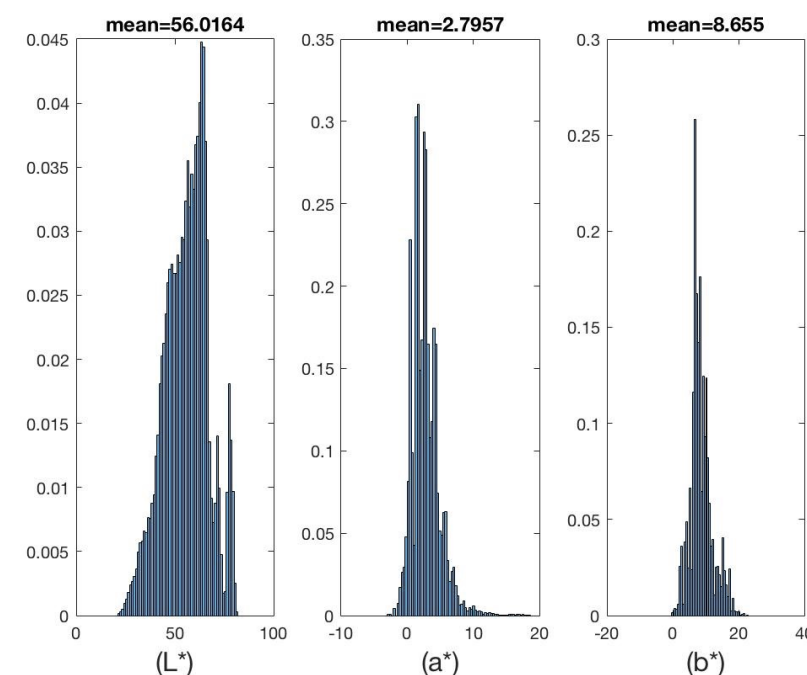


$L^* = 74.93$
 $a^* = 0.97$
 $b^* = 7.48$

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

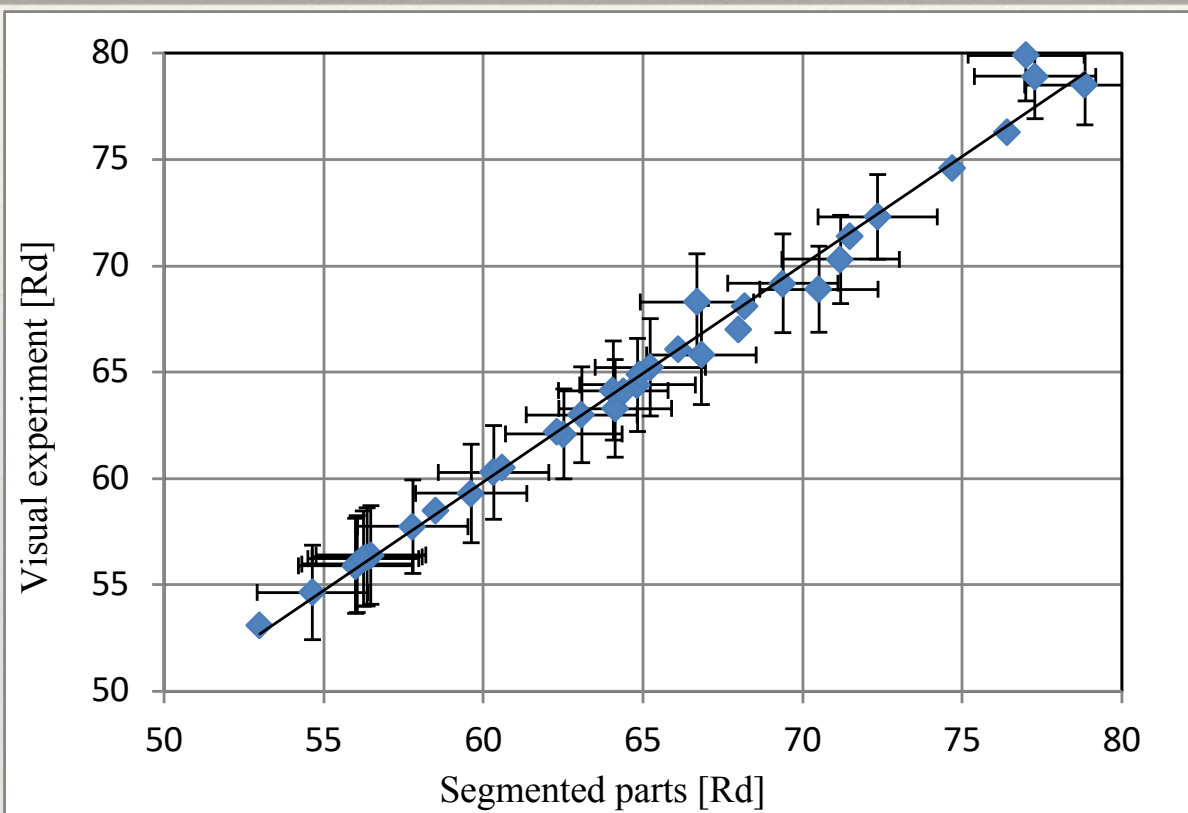


$L^* = 75.42$
 $a^* = 0.93$
 $b^* = 7.45$

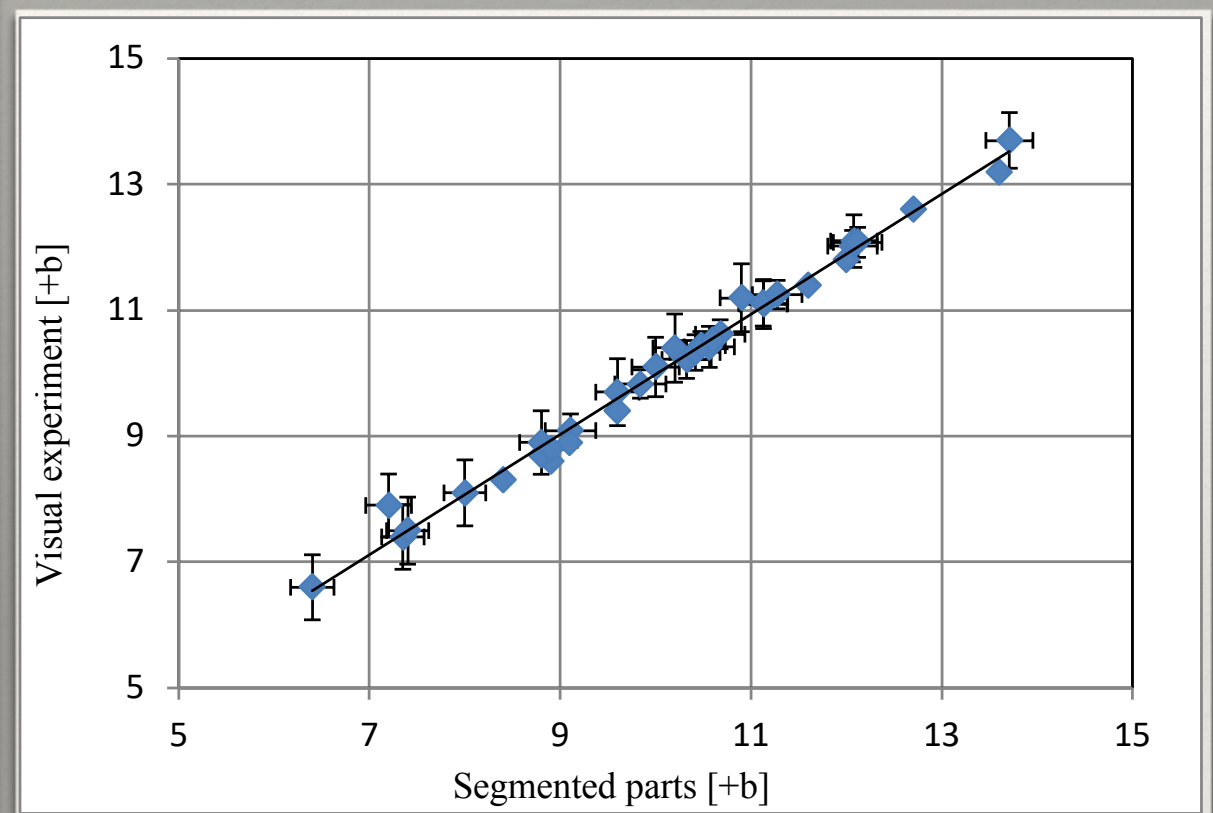


$L^* = 56.02$
 $a^* = 2.80$
 $b^* = 8.66$

Visual assessment 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 $45^{\circ}:0^{\circ}$ 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.