



TOWARD INDIVIDUALIZED IMAGES : QUANTIFYING THE NEED

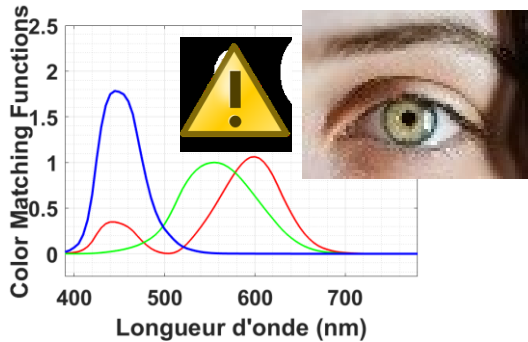
10th June 2022

Emilie Robert, French Spatial Agency (CNES)



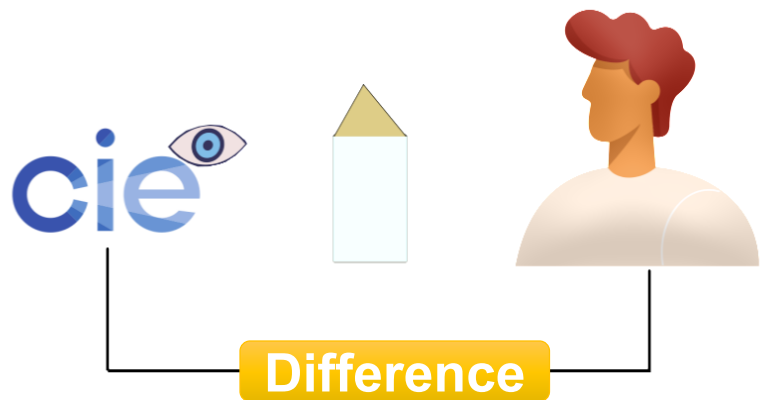
Problem statement

COLORIMETRY

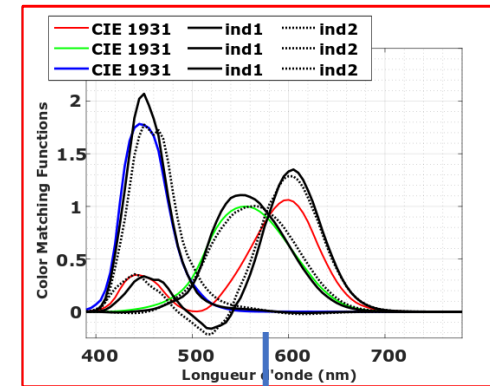


$$\begin{matrix} X \\ Y \\ Z \end{matrix} = \int_{380}^{780} R(\lambda) \cdot I(\lambda) \cdot \begin{matrix} \bar{x}(\lambda) \\ \bar{y}(\lambda) \\ \bar{z}(\lambda) \end{matrix} d\lambda$$

Individualized imaging needed ?



Color vision is not identical for all :

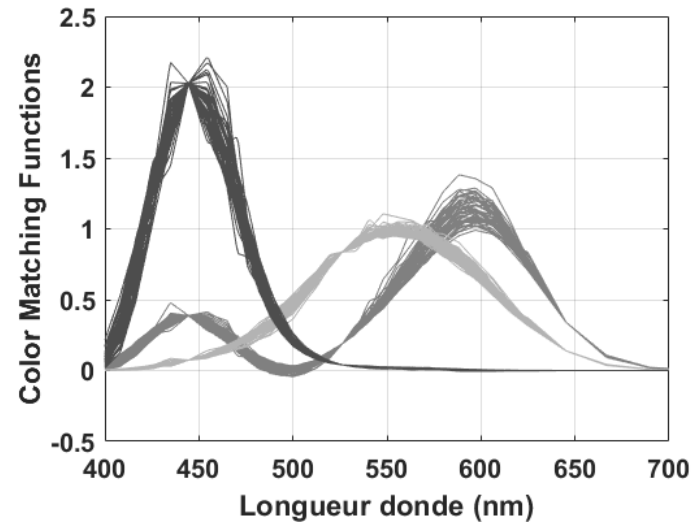


$$\begin{matrix} X \\ Y \\ Z \end{matrix} = \int_{380}^{780} R(\lambda) \cdot I(\lambda) \cdot \begin{matrix} \bar{x}(\lambda) \\ \bar{y}(\lambda) \\ \bar{z}(\lambda) \end{matrix} d\lambda$$

$$T = \begin{bmatrix} X_1 & \dots & X_i \\ Y_1 & \dots & Y_i \\ Z_1 & \dots & Z_i \end{bmatrix} \rightarrow T = M \times C$$

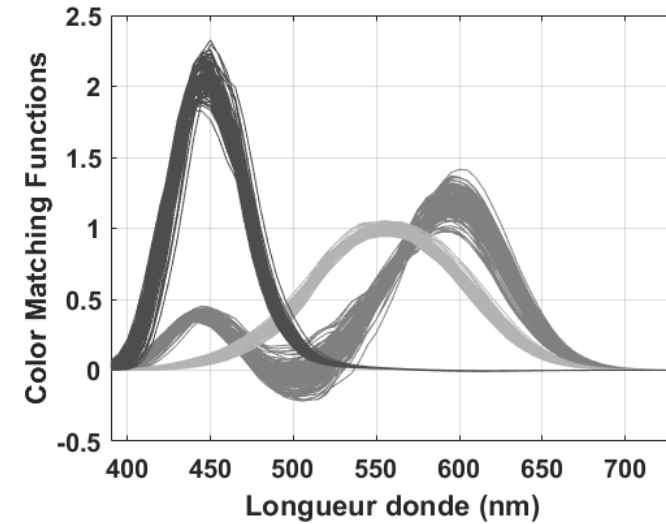
T : target colorimetry
 C : raw images RGB values
 M : Color Correction Matrix

Data sets under study



Stiles et Burch, 1959

- 47 observers
- Between 16 and 55 yo
- Medium age : 32 yo

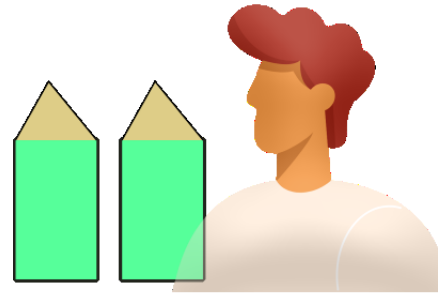


Asano, 2015

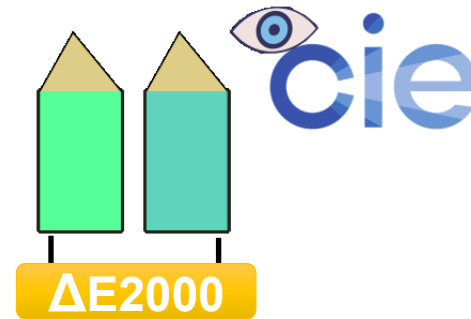
- 151 observers
- Between 20 and 69 yo
- Medium age : 40 yo

Methodology in literature

Observer's equalization



How different for CIE standard observer



Methodology

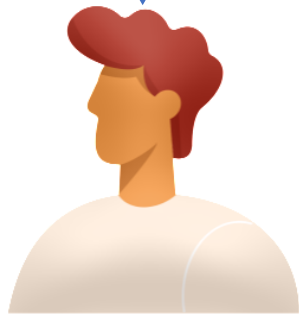


NEW: quantification method

$$\begin{matrix} X_{CIE} \\ Y_{CIE} \\ Z_{CIE} \end{matrix} = \int_{380}^{780} R(\lambda) \cdot I(\lambda) \cdot \begin{matrix} \bar{x}(\lambda) \\ \bar{y}(\lambda) \\ \bar{z}(\lambda) \end{matrix} d\lambda$$

$$\begin{matrix} X_{IND} \\ Y_{IND} \\ Z_{IND} \end{matrix} = \int_{380}^{780} R(\lambda) \cdot I(\lambda) \cdot \begin{matrix} \bar{x}(\lambda) \\ \bar{y}(\lambda) \\ \bar{z}(\lambda) \end{matrix} d\lambda$$

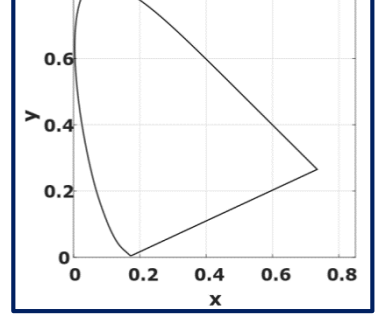
cie



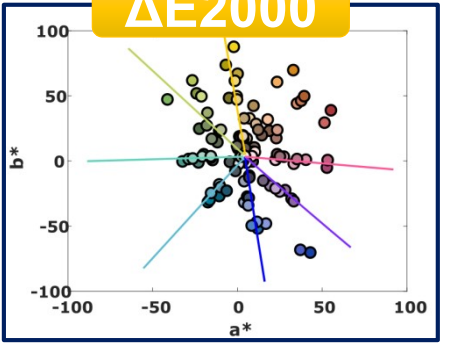
NGTarget, Avian Rochester

Difference

Error ellipses



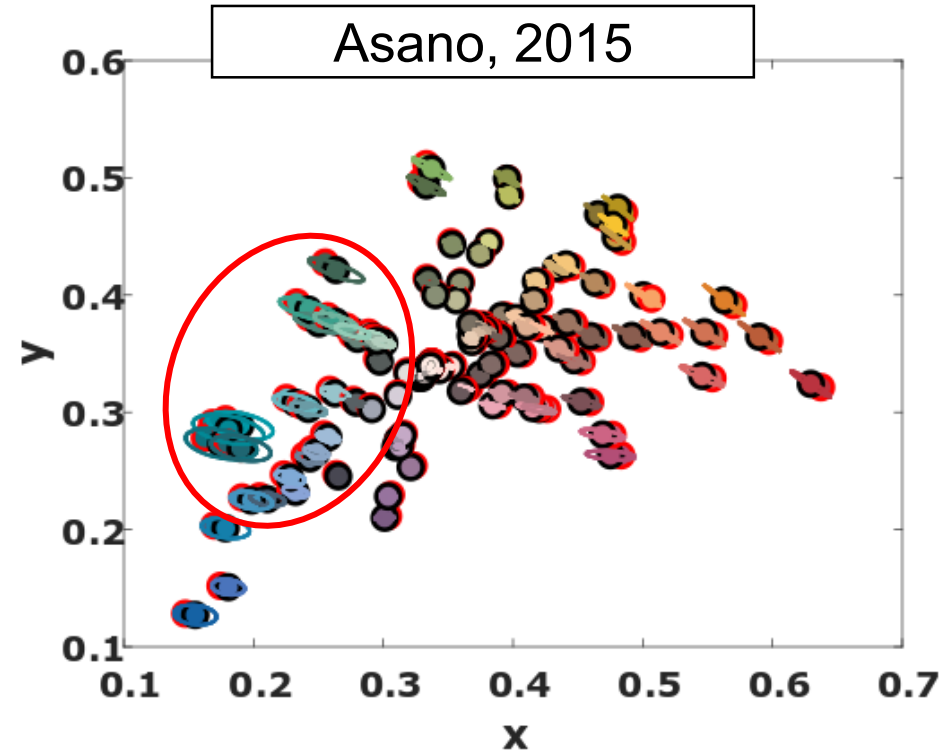
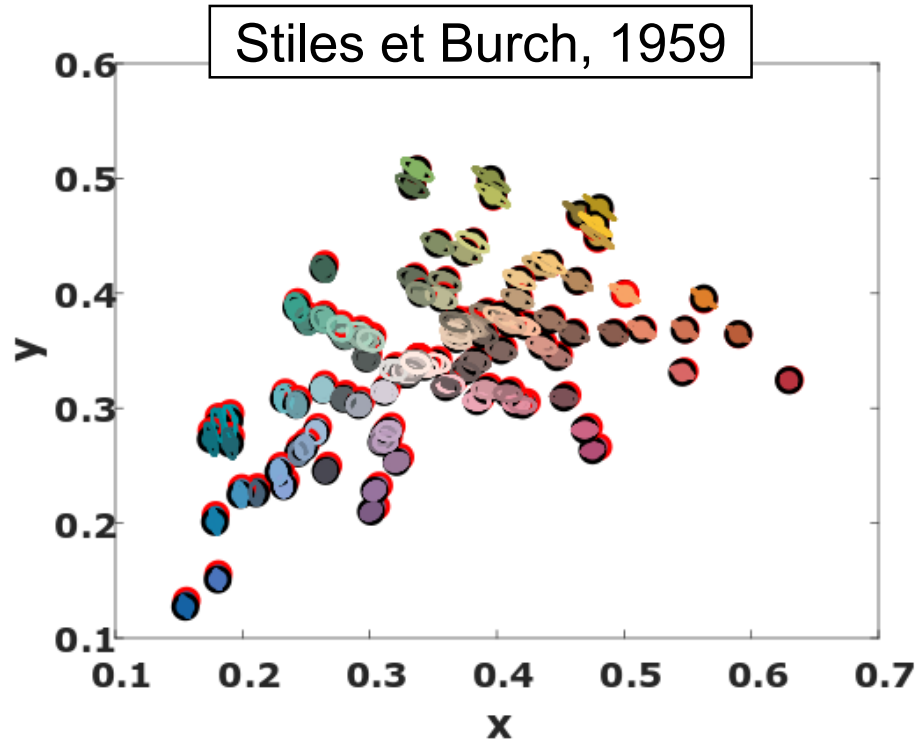
ΔE2000



Results

Error ellipses

Définition: For each patch of the NGT color chart (under EEW illuminant), an ellipse contains the x,y chromaticity values for all the observers.

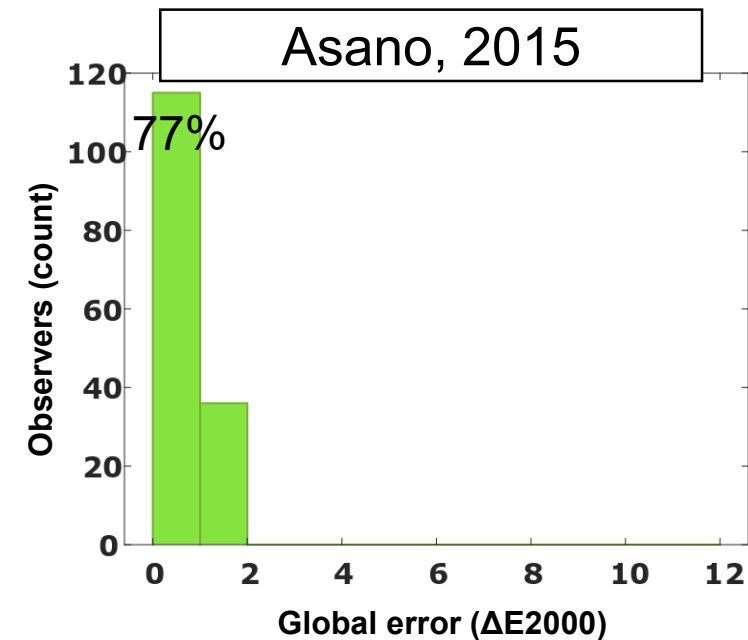
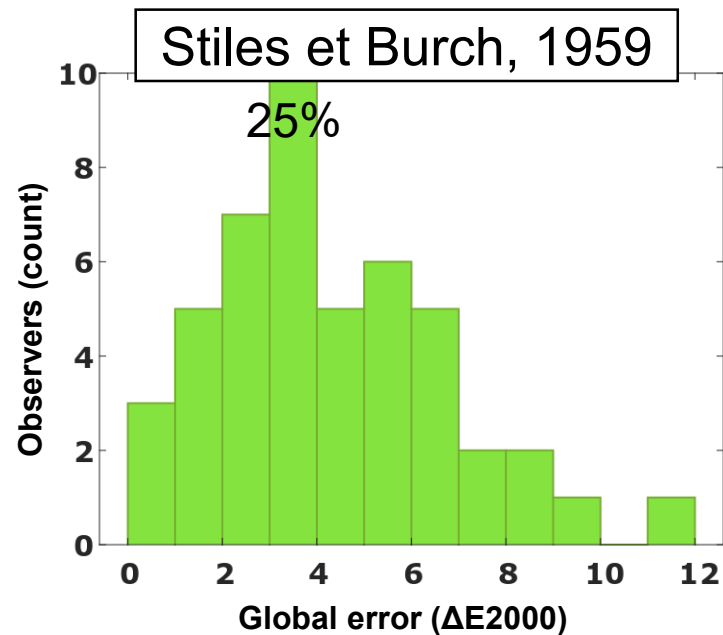


- Some hues show larger differences

Results

ΔE_{2000}

Definition: ΔE_{2000} global i.e averaged over all the NGT patches.

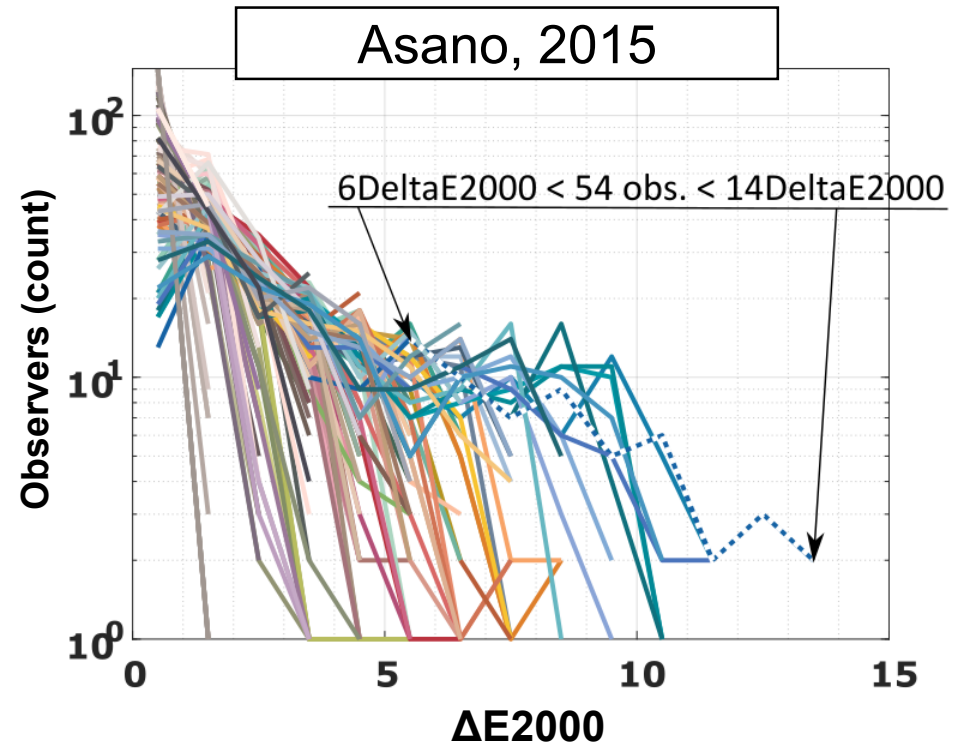
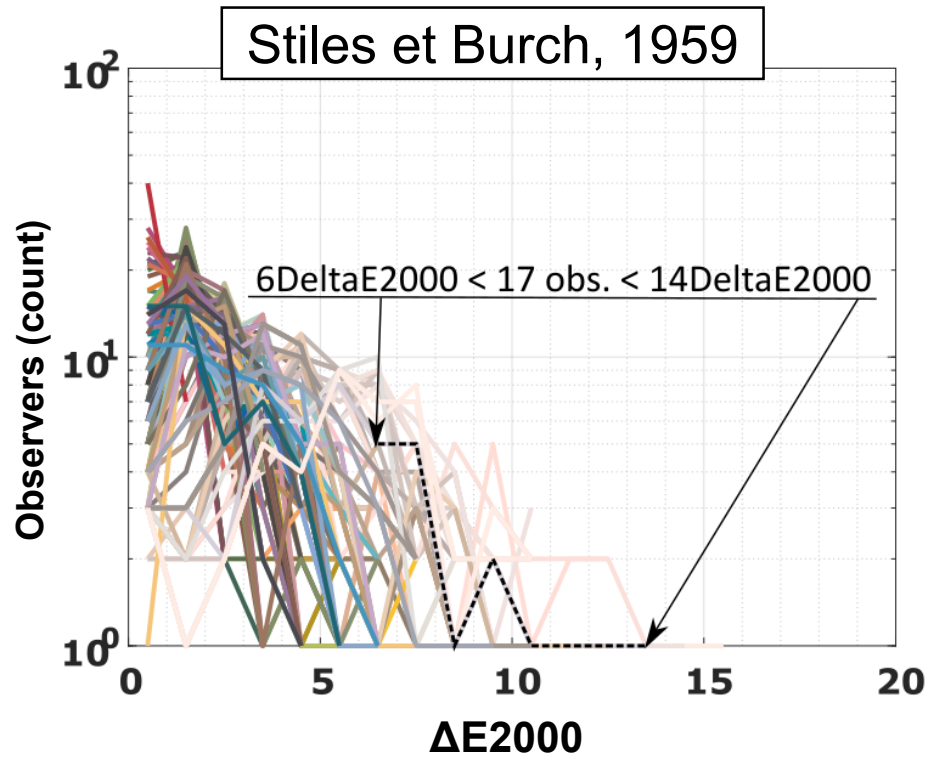


➤ Do not rely only on global values...

Results

ΔE_{2000}

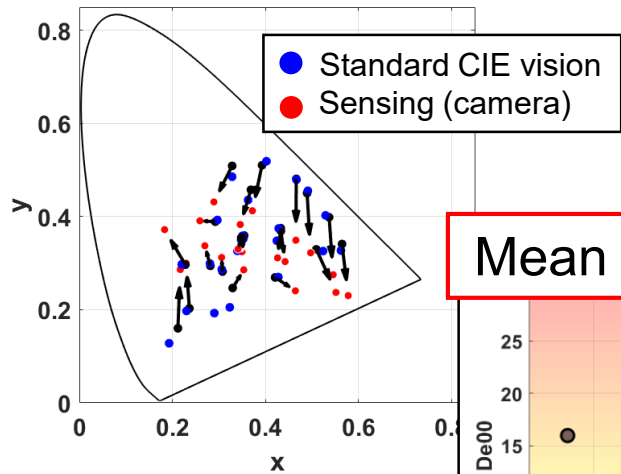
Definition: ΔE_{2000} for each patch of the NGT.



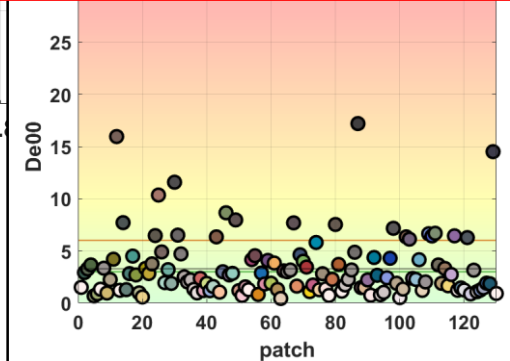
- Same hues as with error ellipses. On these, 36% of observers are affected by large differences in vision from the standard.

Conclusion

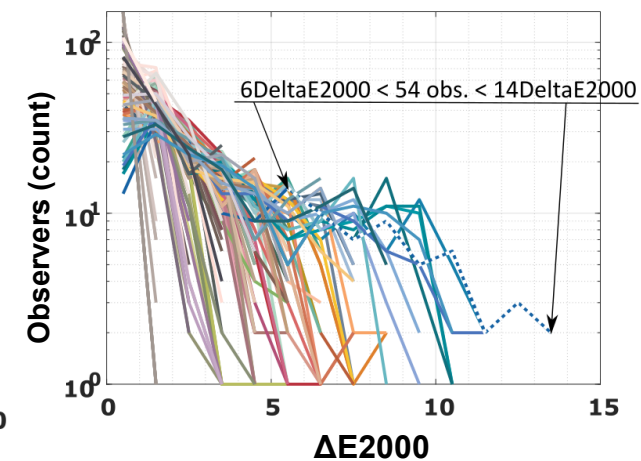
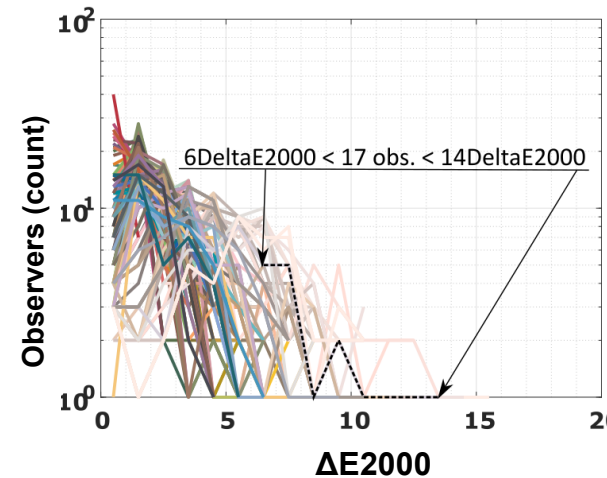
INDIRECT VISION CHAIN



Mean = 3,3 ΔE_{2000}



> 6 ΔE_{2000} for 36% of normal observers



Conclusion

→ **Need to make individual imaging possible: must go through the characterization of individual vision**

→ Through categorization : Sarkar 2011, Asano 2015, Yuan 2021

→ Through equalization experiment : few in the world, 1 in development at DGA-TA, Balma, France



(contact justin.plantier@def.gouv.fr)



Emilie Robert, Magali Estriebeau, Rémi Barbier, Greggory Swiathy, Justin Plantier, et Pierre Magnan. ***Development of a large switchable gamut equalization experiment setup***, Poster In London Imaging Meeting, 2020.



Thank you!

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