

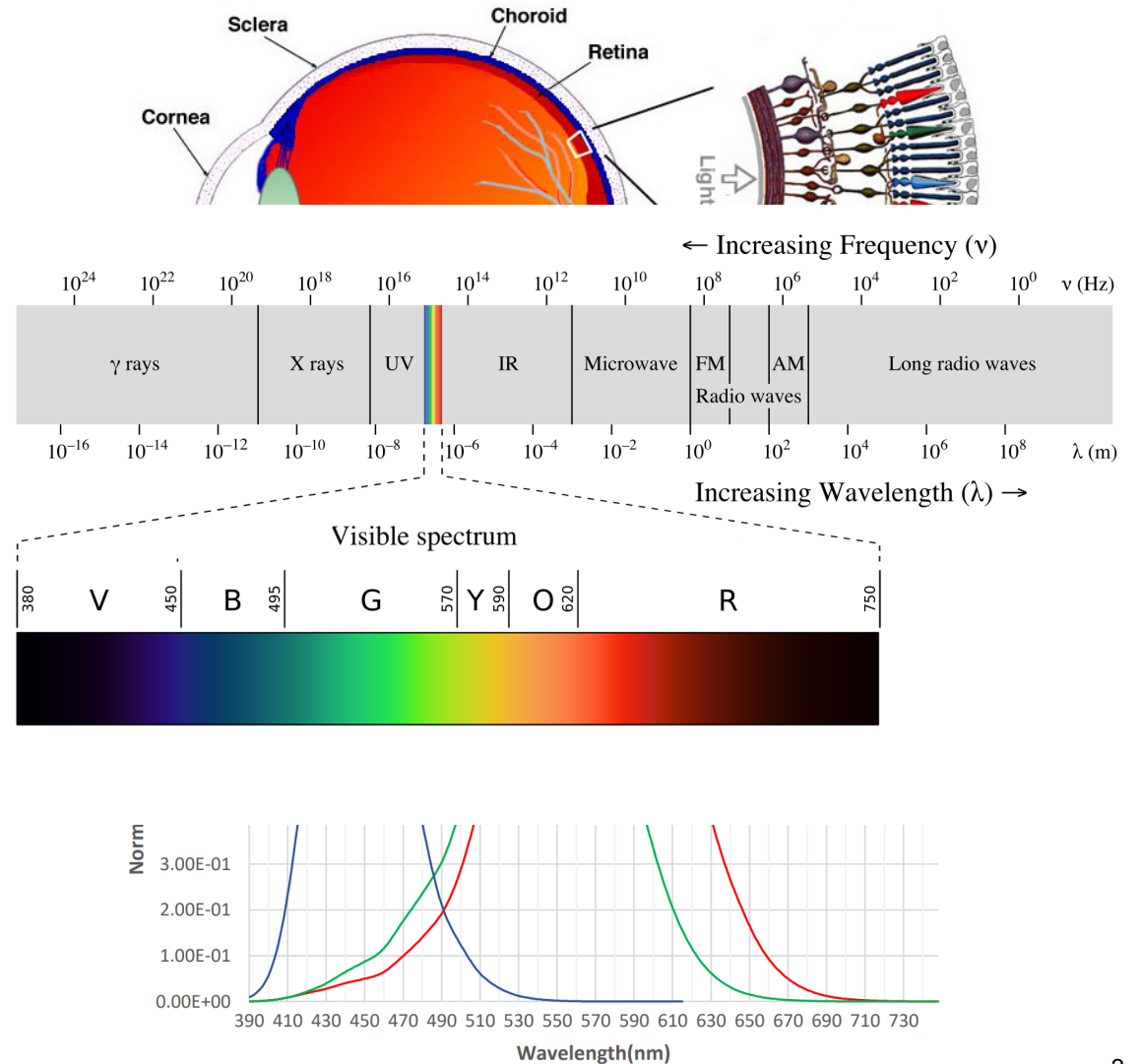
How to Define a Color

TI Precision Labs – Light Sensors

Presented and prepared by Nicole Khoury

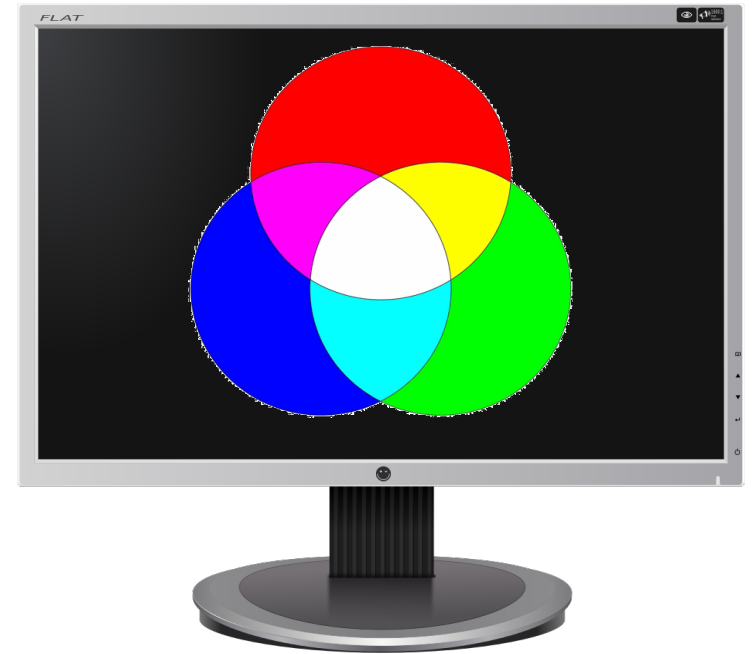
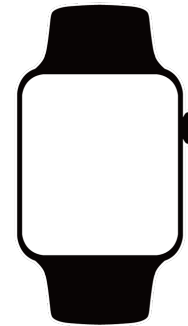
Colors

- Rods:
 - Sense brightness in low light conditions
- Cones:
 - Sense both brightness and color
 - Long, medium, and short cones are sensitive to different visible wavelengths
- Visible light
 - 380 nm to 750 nm
- Each wavelength in the visible range corresponds to a specific color
 - How does the human eye interpret different combinations of these wavelengths?

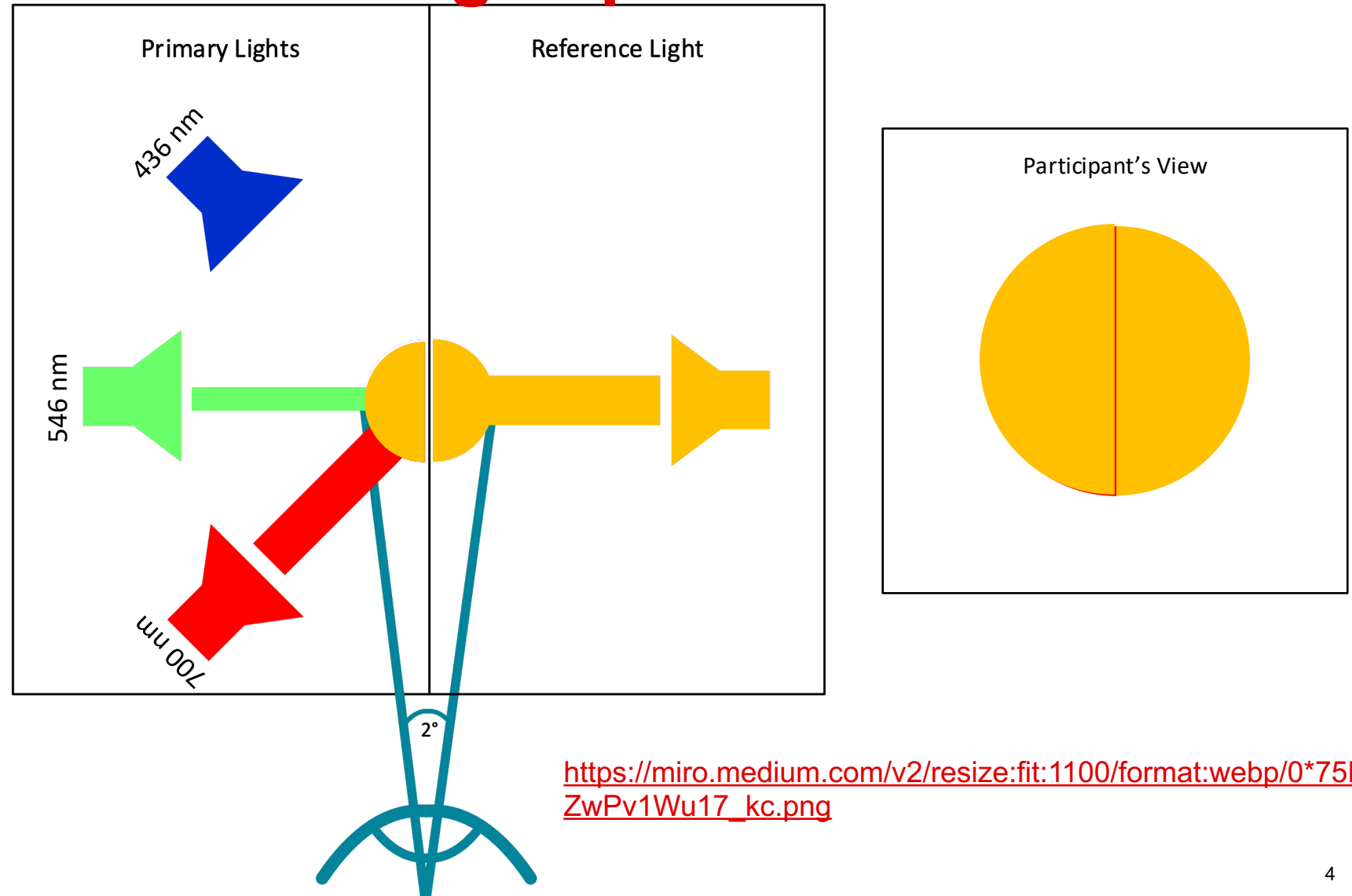


Displays

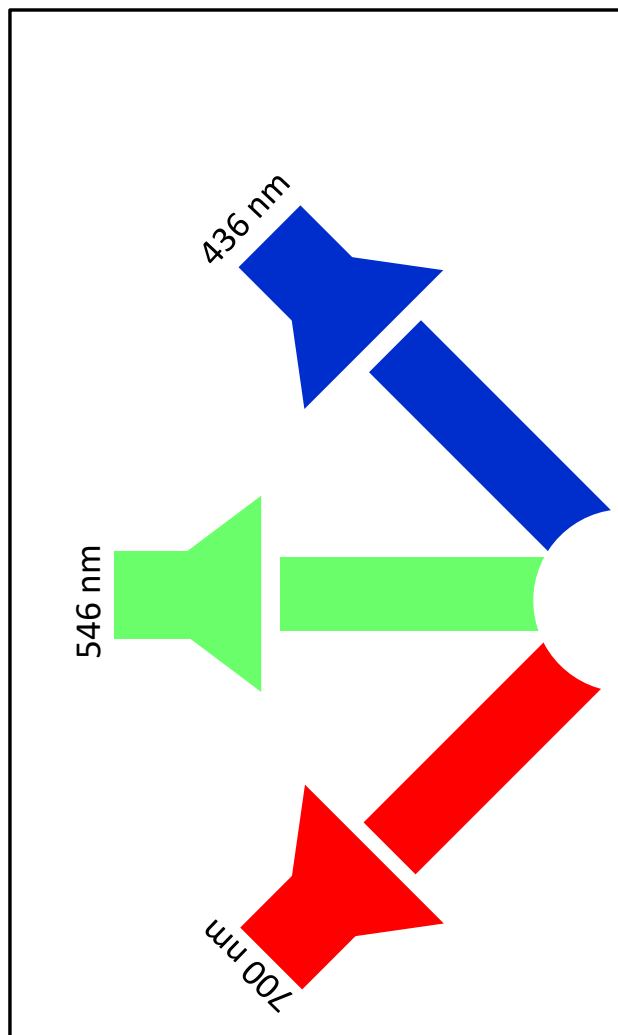
- Display technology
 - Utilize 3 primary colors to mix and produce other colors
 - Primary color sources can be emitters or color filters
- Additive color mixing
 - When wavelengths are added together to create a new color
 - Ex: The RGB LEDs in an LCD monitor can be combined to create yellow



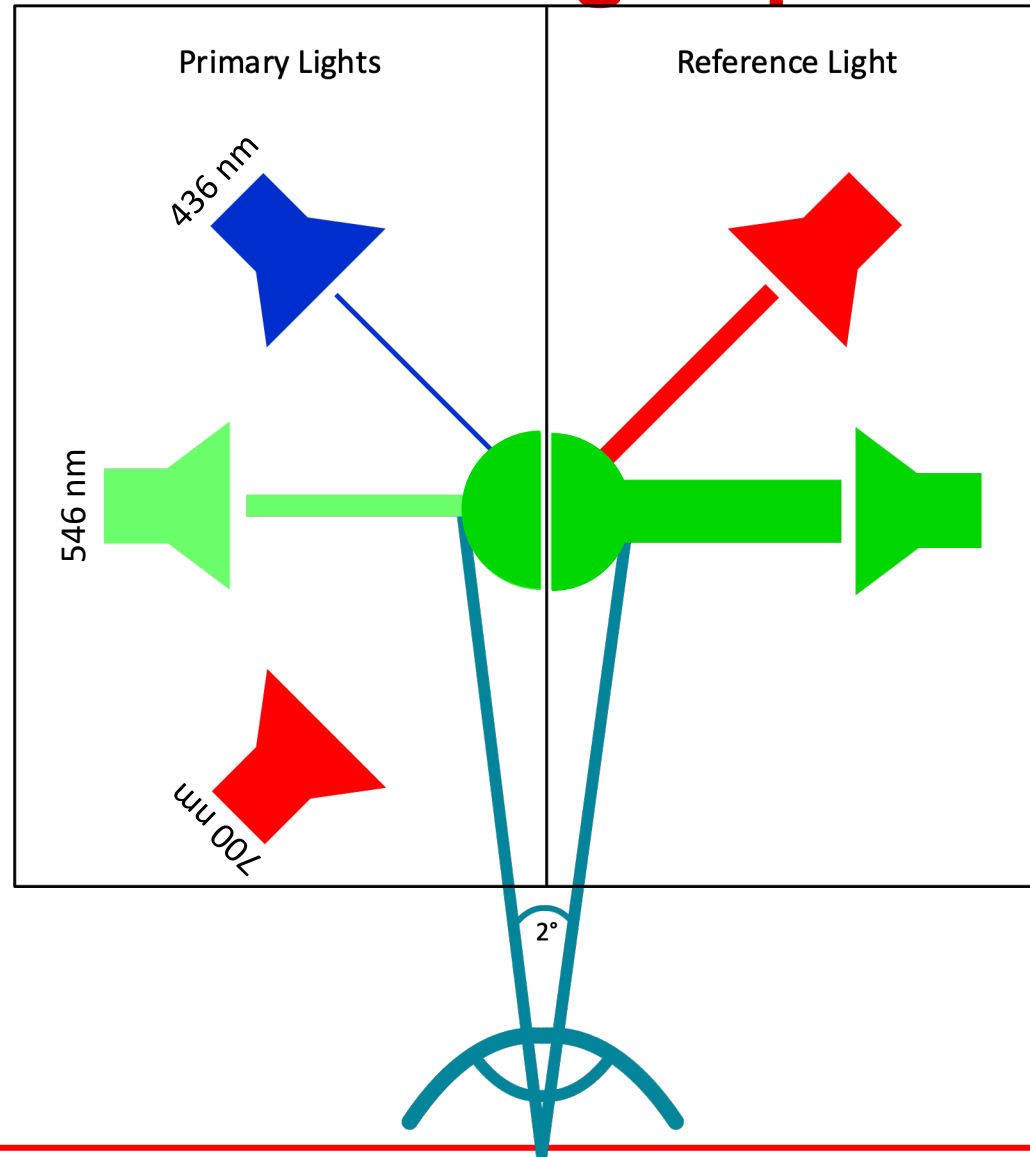
Wright-Guild color matching experiments



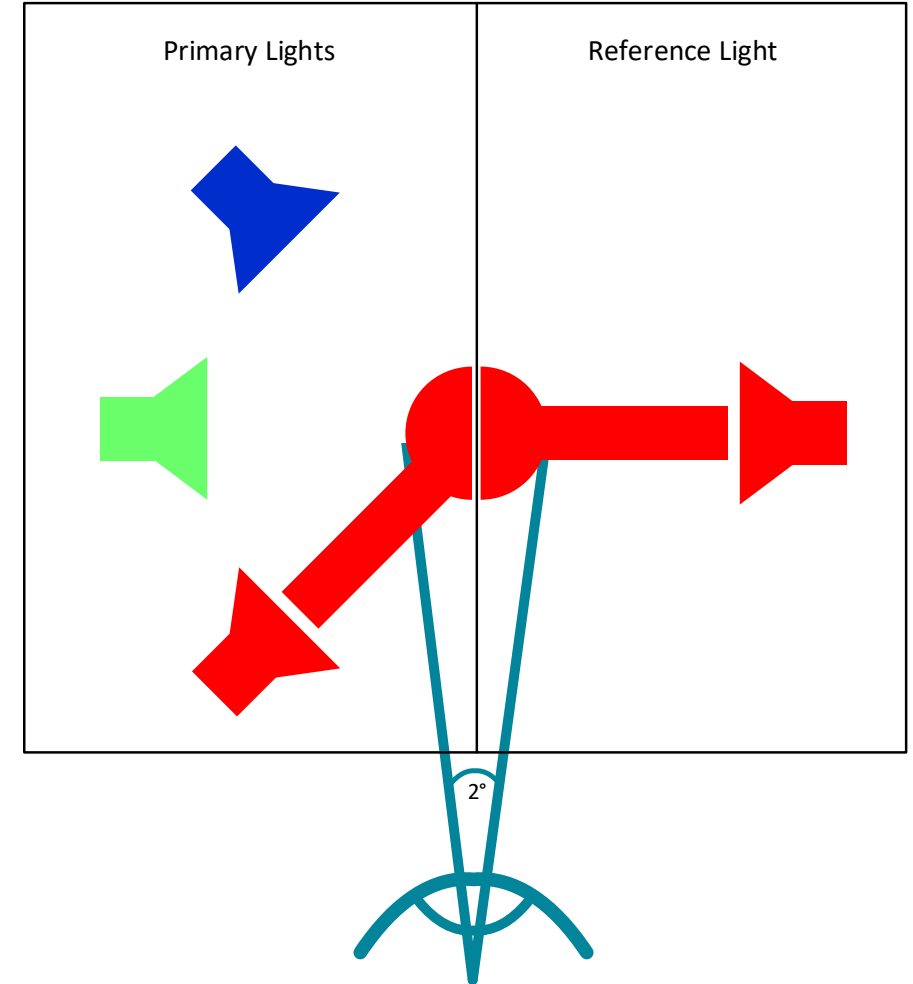
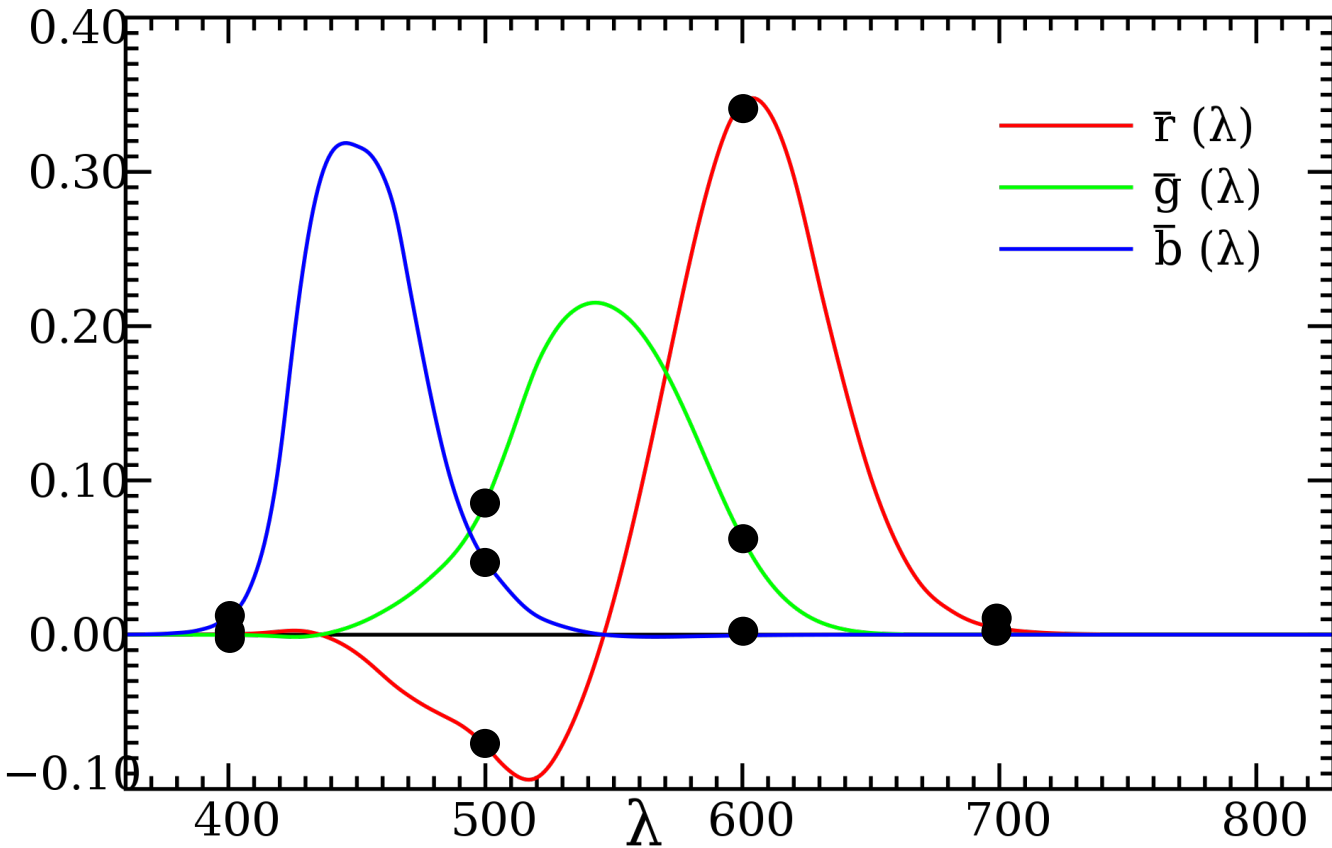
Wright-Guild color matching experiments



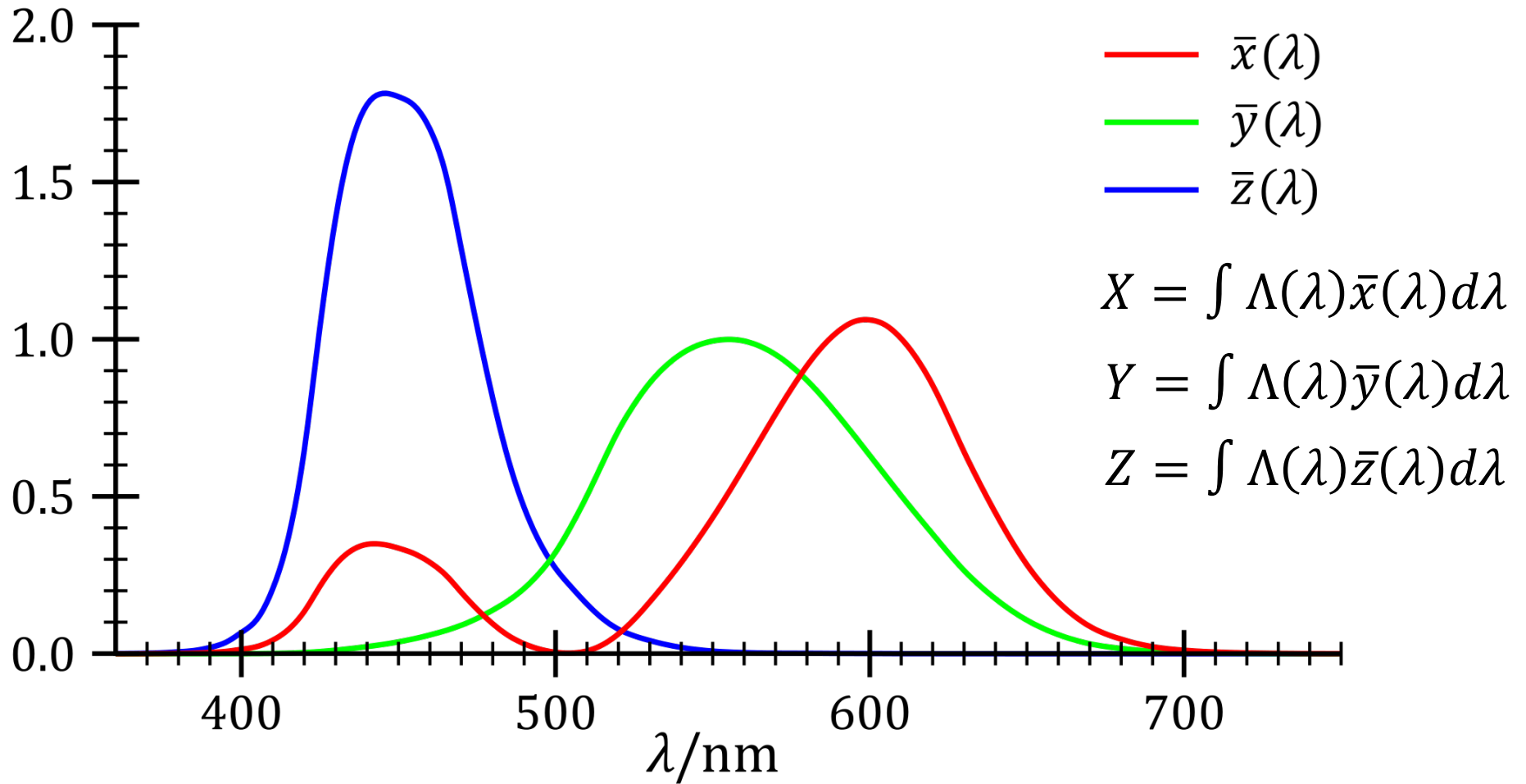
Wright-Guild color matching experiments



Color matching functions



Color matching functions



Tristimulus values

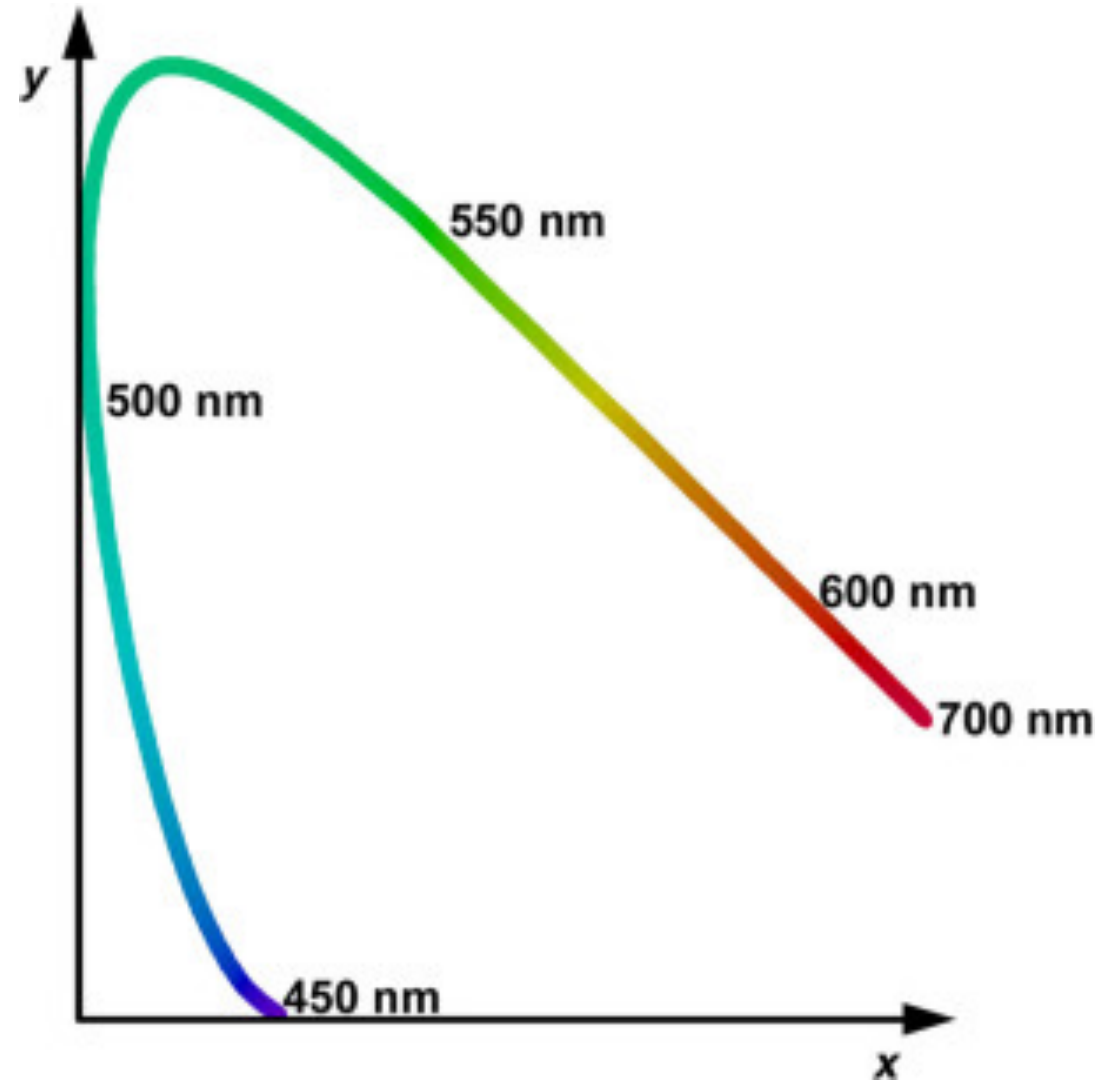
$$x = \frac{X}{X + Y + Z}$$

$$y = \frac{Y}{X + Y + Z}$$

$$z = \frac{Z}{X + Y + Z}$$

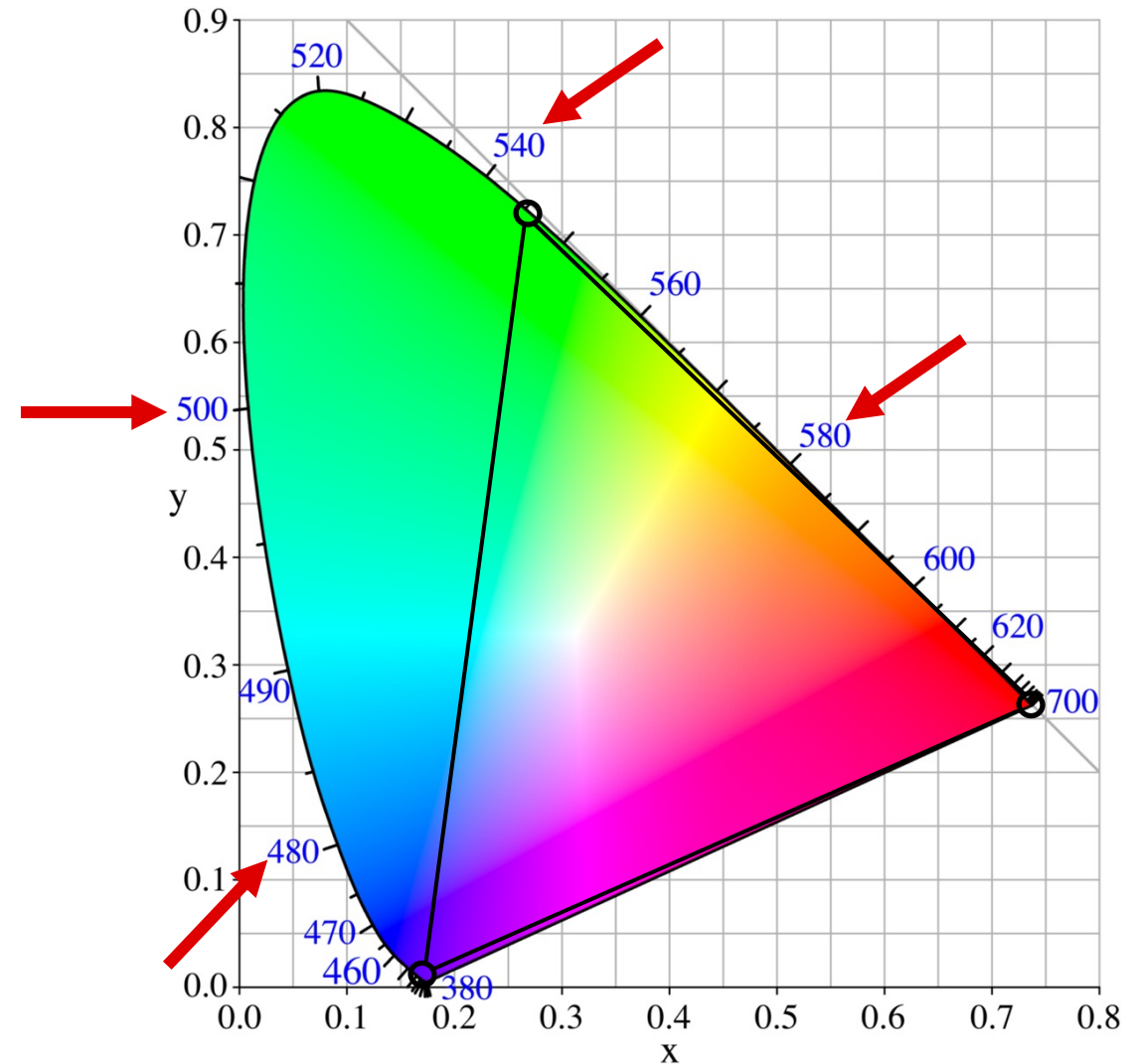
The spectral locus

- Monochromatic wavelengths
 - Light created by a single wavelength
- Projection is independent of light intensity
- Derived from the spectra of human eye response



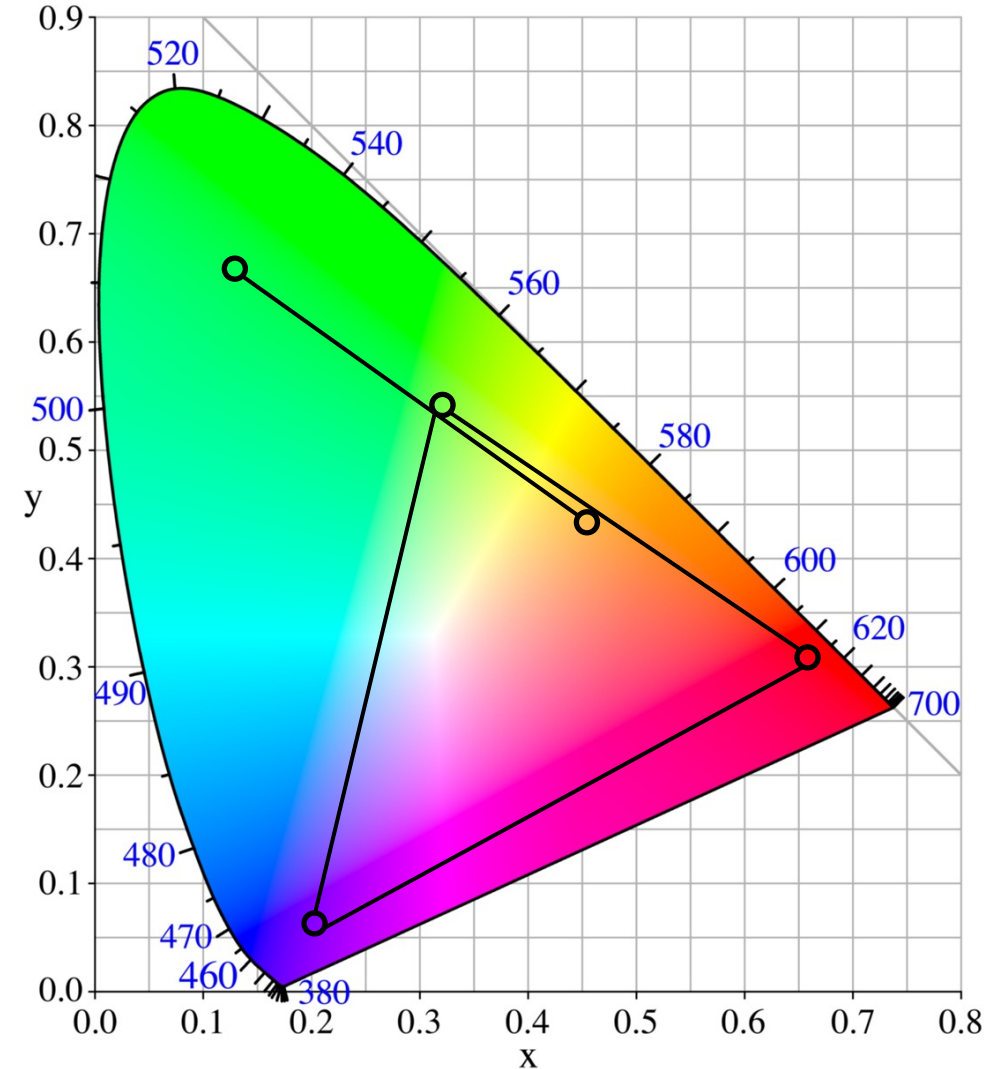
Color spaces

- Allow for different methods of organizing colors
 - CIE 1931 XYZ was the first standardized color space, based off of human perception data from Wright and Guild experiments
- Spectral Locus
 - Curved edge of the color space
 - Contains the monochromatic wavelengths
 - Light created by a single wavelength
 - All interior points are created with combinations of other wavelengths



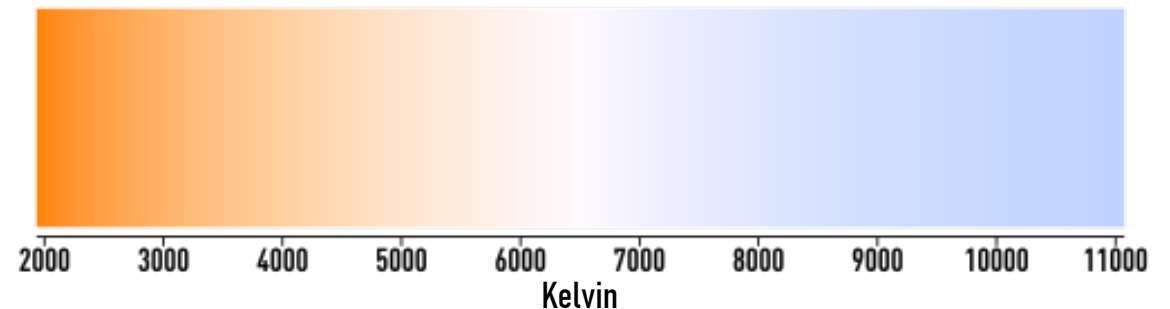
Color spaces

- Any two or more points within a color space will create a subset of colors
 - Subset colors can be reproduced using the colors at the endpoints/vertices



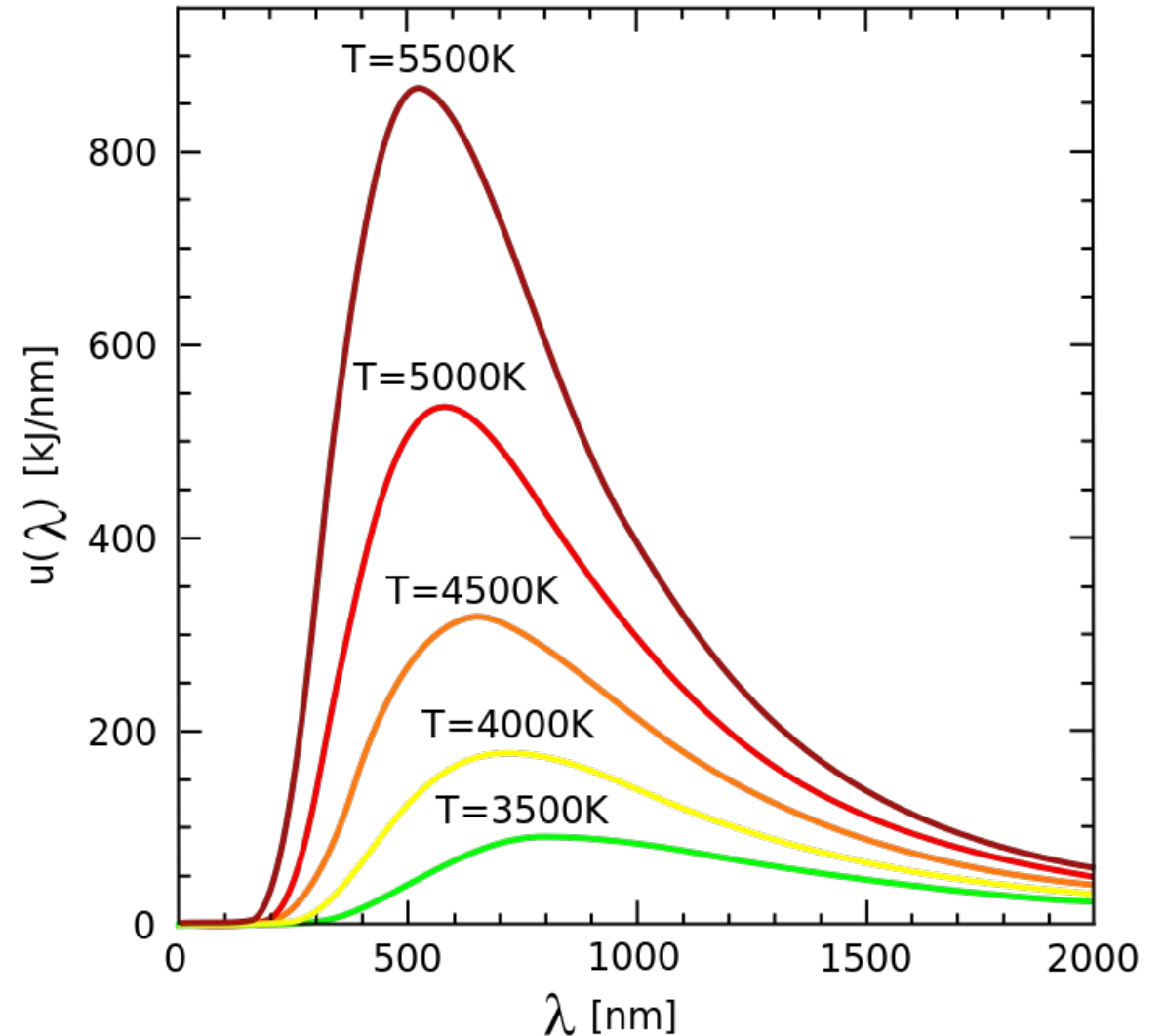
Color temperature

- Kelvin measurement corresponding to white light with varying amounts of other primaries
 - “Warmer”: more yellow and orange
 - “Cooler”: more blue wavelengths
- Standardization of different white lights across manufacturers and source types
 - Users know that two 5000K LED bulbs will have similar properties
 - Different color temperatures will illuminate objects differently



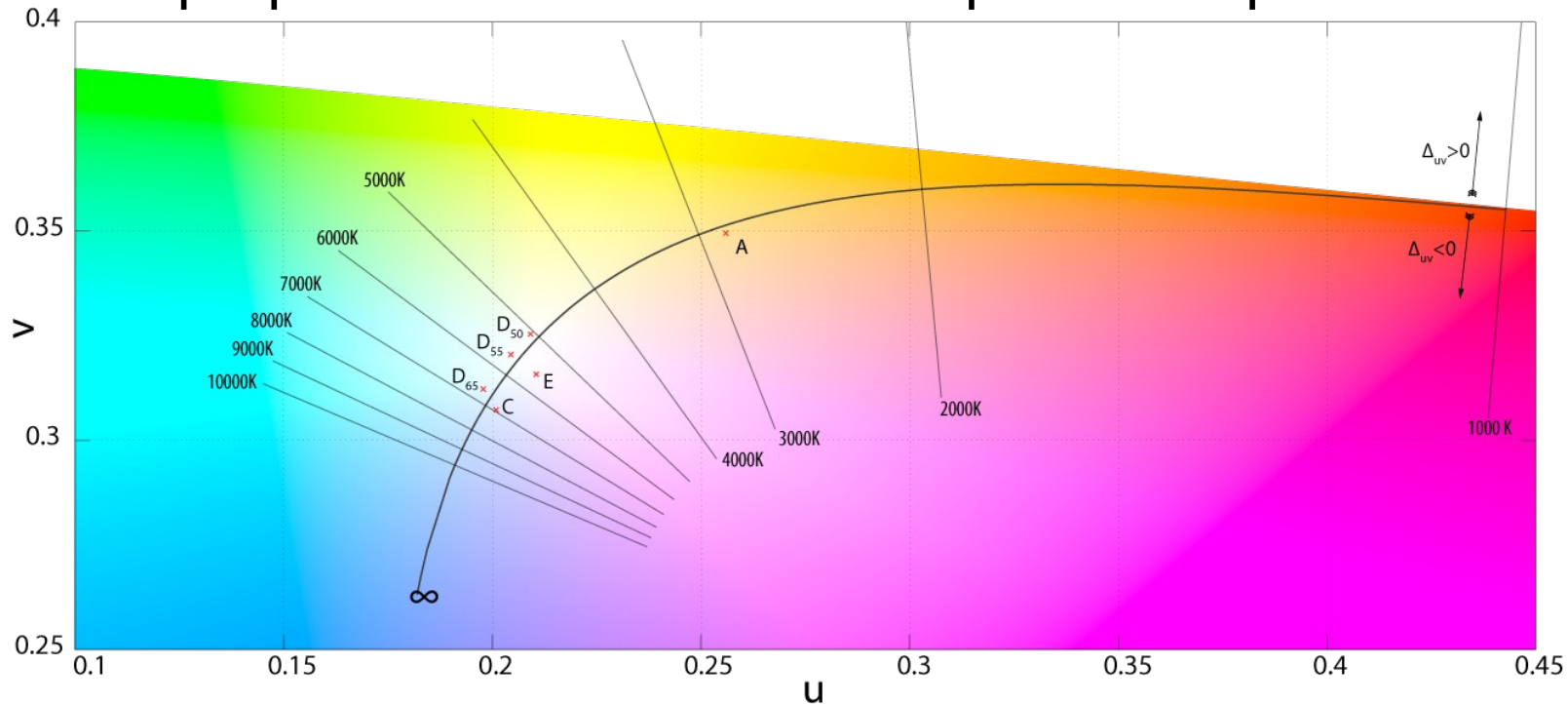
Color temperature

- Correlated color temperature (CCT)
 - Color temperature of black body radiator that most closely correlates with a given source light
- What is a Planckian radiator?
 - Ideal, opaque, non-reflective object
 - Emits black-body radiation dependent on temperature (Kelvin)



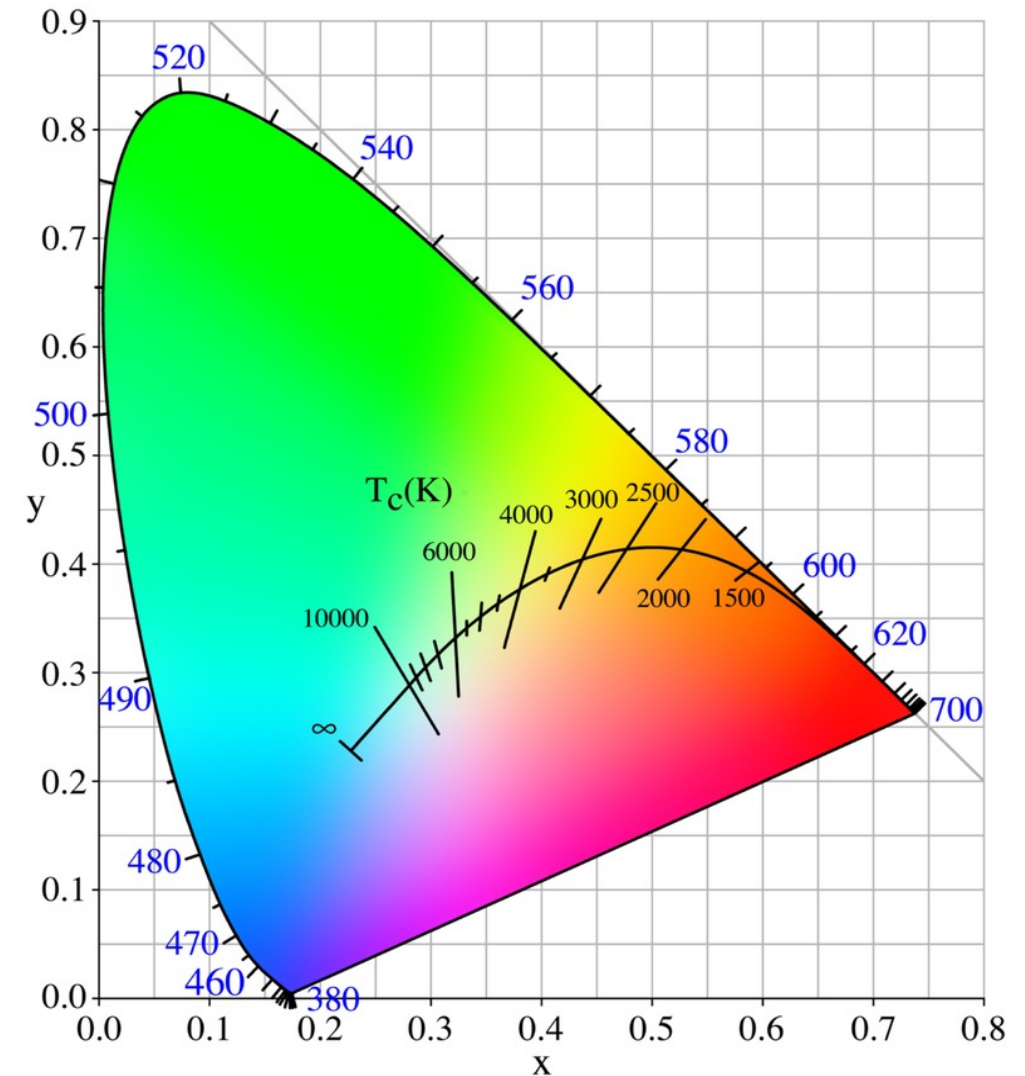
Color temperature

- Planckian locus
 - The curve of the Planckian radiation as temperature increases
 - Perceived color of the radiation changes with temperature
- Isothermal lines perpendicular to the locus represent equal CCT values

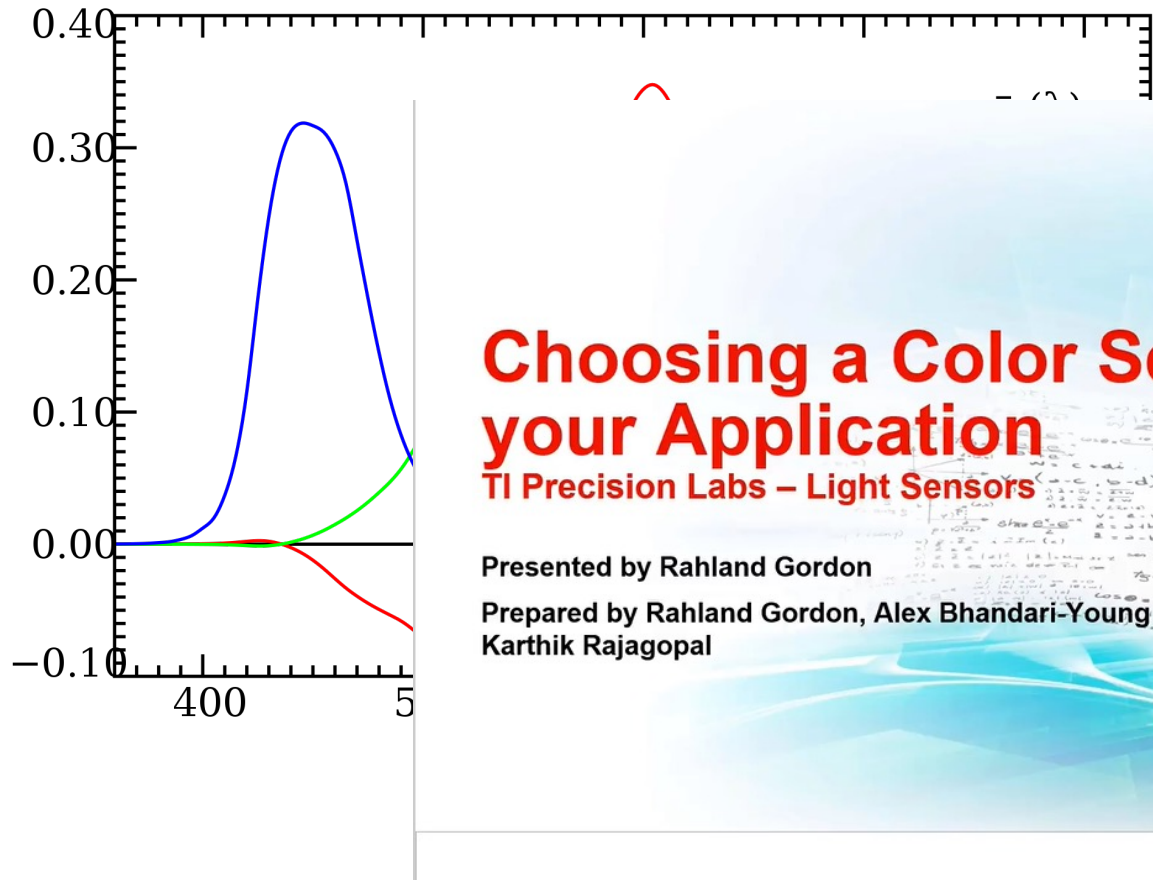


Color temperature

- Planckian locus projected onto CIE color space
 - Allows for distinguishing color differences between individual CCT values
- Various points in the color space will have corresponding color and CCT values



Summary

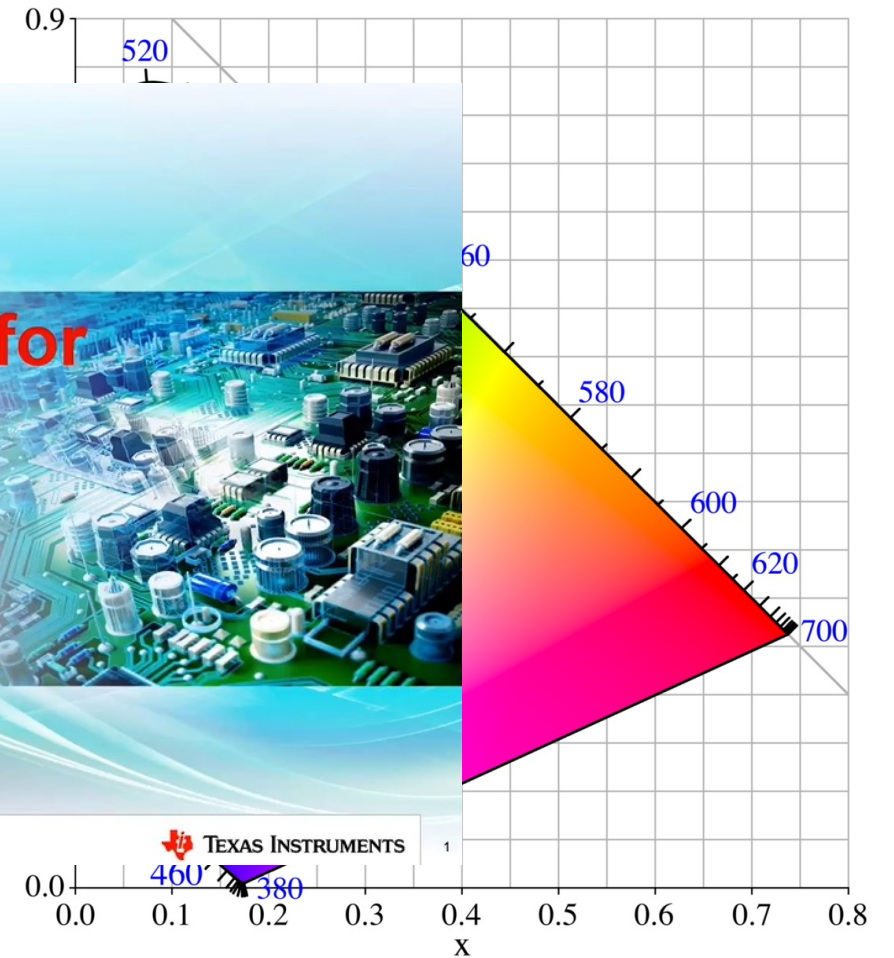


Choosing a Color Sensor for your Application

TI Precision Labs – Light Sensors

Presented by Rahland Gordon

Prepared by Rahland Gordon, Alex Bhandari-Young and
Karthik Rajagopal



To find more light sensor technical resources and search products, visit **ti.com/<insert product portal>**.

Thanks for your time!
Please try the quiz.

Quiz

A target color is created with various amounts of red, green, and blue light. What happens to the target color when the intensity of each primary is increased by the same amount?

- a) The target color stays the same
- b) The target color becomes brighter
- c) The target color becomes dimmer
- d) The wavelength of the target color decreases



Quiz

What color will be created with equal intensities of 700 nm, 546 nm, and 436 nm?

- a) Black
- b) There is no way to know
- c) White
- d) It depends on the intensity



Quiz

The spectral locus plots color temperature coordinates.

- a) True
- b) False

