

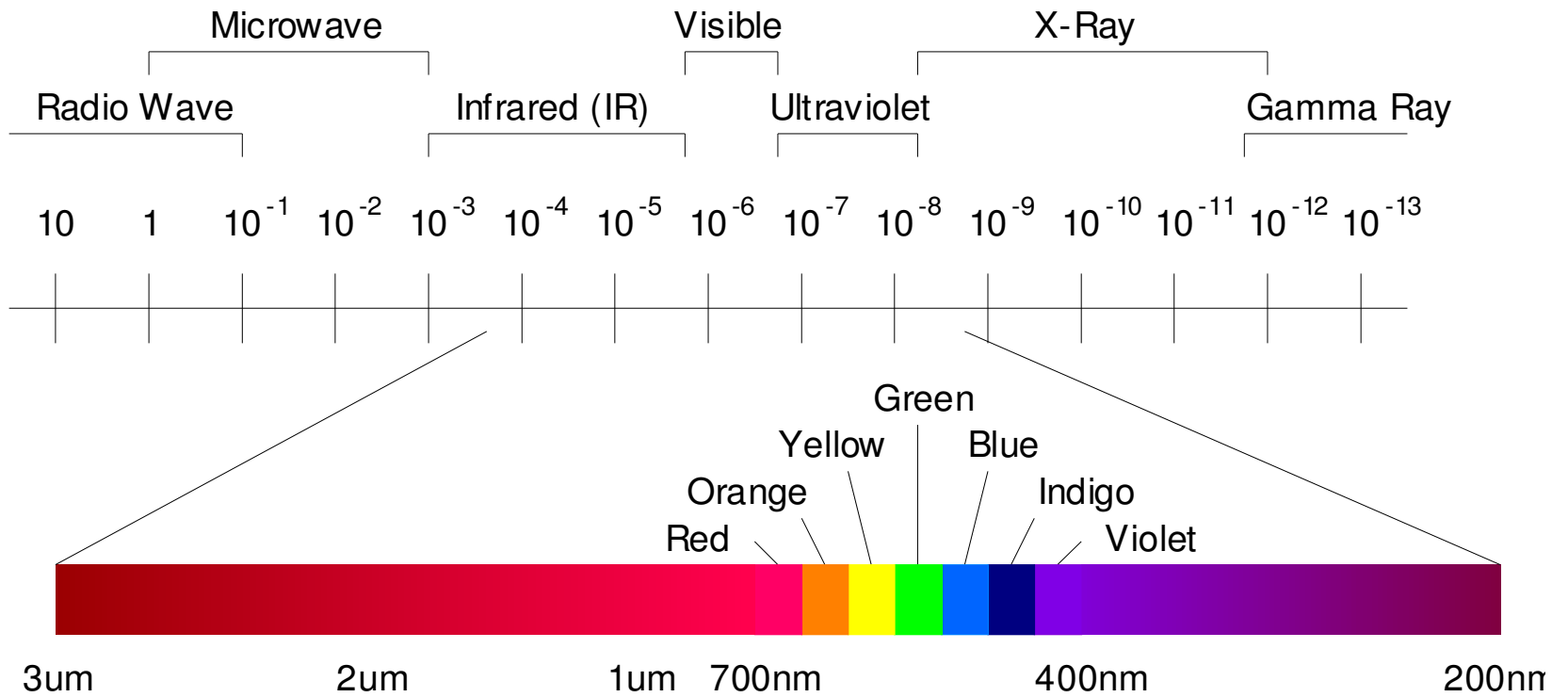
Fundamentals of Color Measurement

ISA NorCal TECH May 2

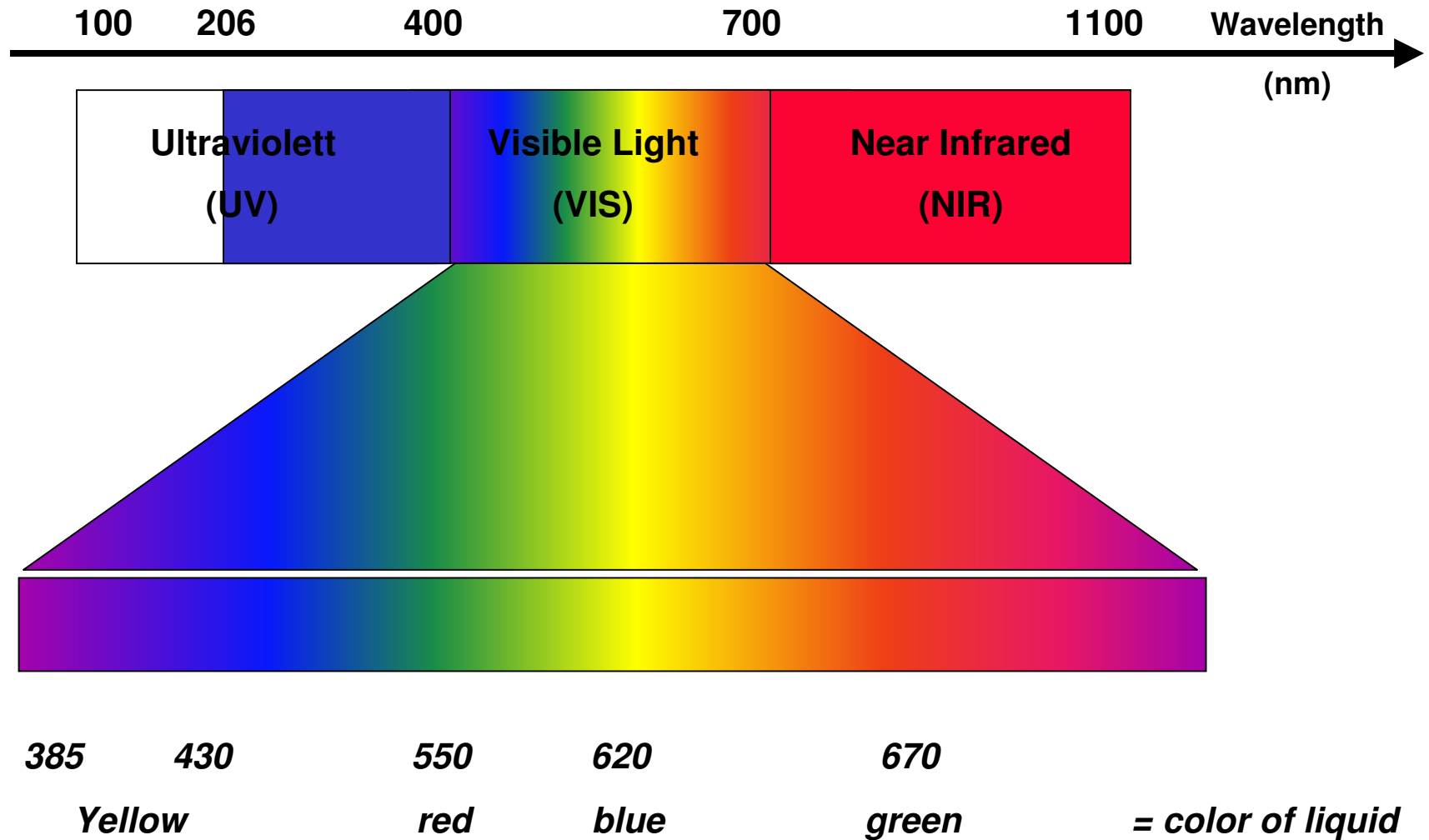
Bill Deutschlander

WorleyParsons 925-313-5628

Spectrum of Light



Spectrum of Color measurement

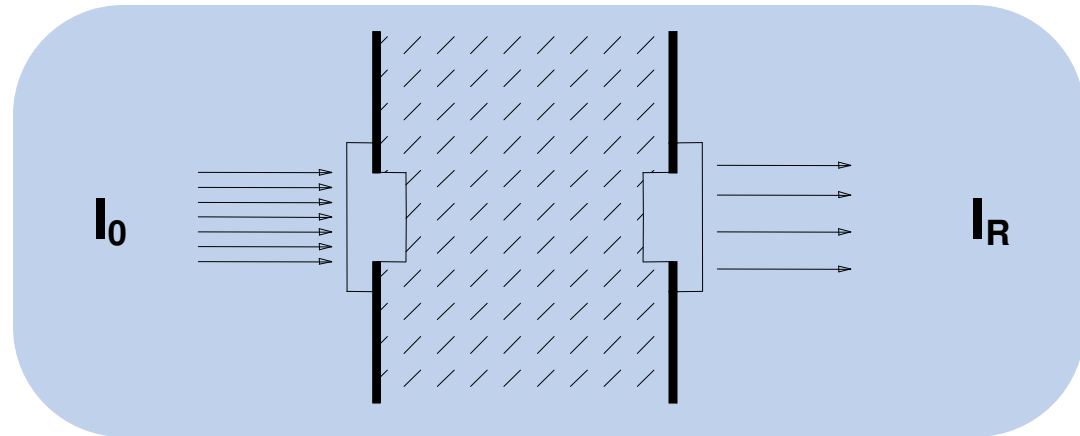


Color Scales and Terms

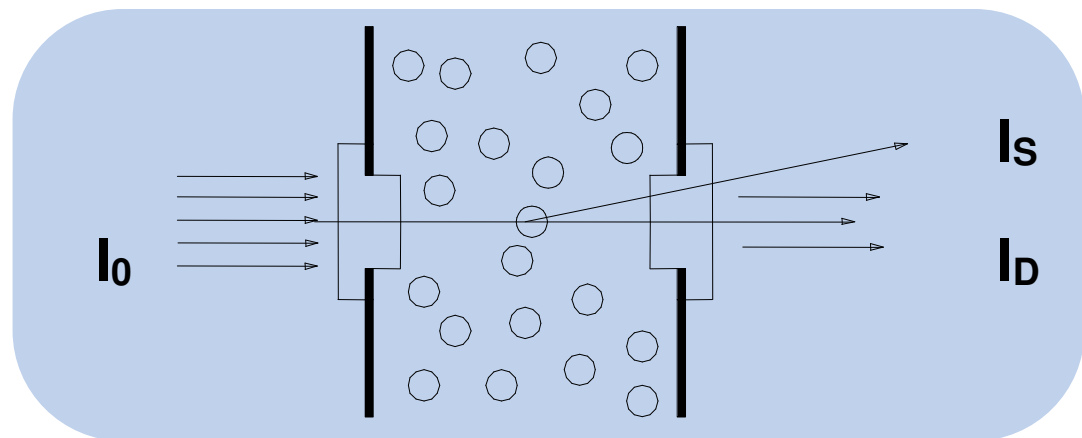
- APHA - American Public Health Assoc., Hazen Standard
- ASTM – American Society for Testing and Materials, Hazen and SayBolt Standards
- EBC – European Brewery Convention; 430 nm, 1 cm
- Hazen – Unit of the Color Standard Scale for APHA/ASTM. Also know as Pt-Co.
- Saybolt – Color Scale unit for Petroleum Products based upon visual comparison of Optical Filters

Photometry - Principles

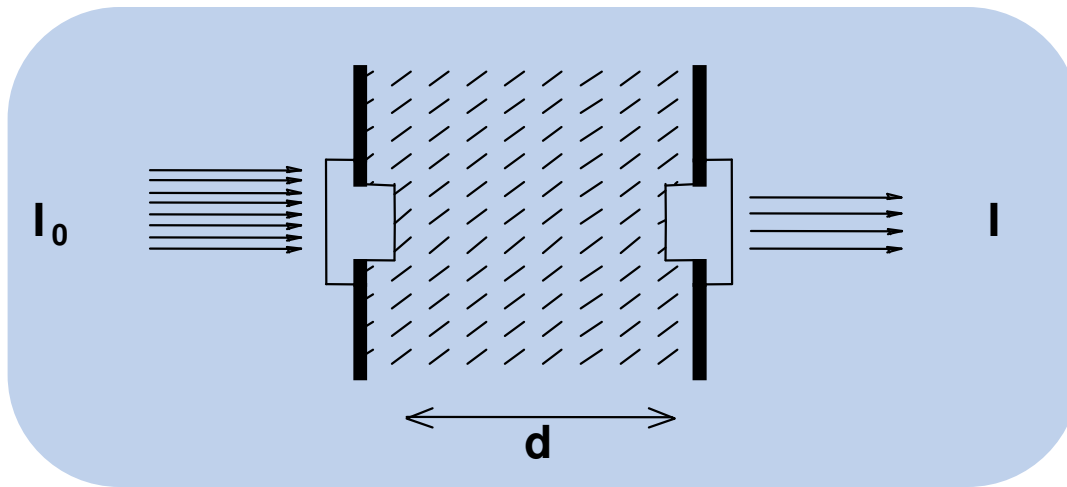
Absorption of light:



Scattering of light:



Absorption - Lambert Beer's Law I



$$I = I_0 \cdot \exp[-\epsilon \cdot c \cdot d]$$

$$T = I / I_0$$

$$A = -\log T = \epsilon \cdot c \cdot d$$

A: Absorbance

T: Transmission

ϵ : Molar decaying coefficient of absorption ($l / \text{mol} \cdot \text{cm}$)

c: Concentration of absorbing substance (mol / l)

d: optical path length (OPL) (cm)

Absorption - Lambert Beer's Law II

Units of Absorption:

$$A = -\log T = \epsilon \cdot c \cdot d$$

A: Absorbance

E: Extinction (Europe)

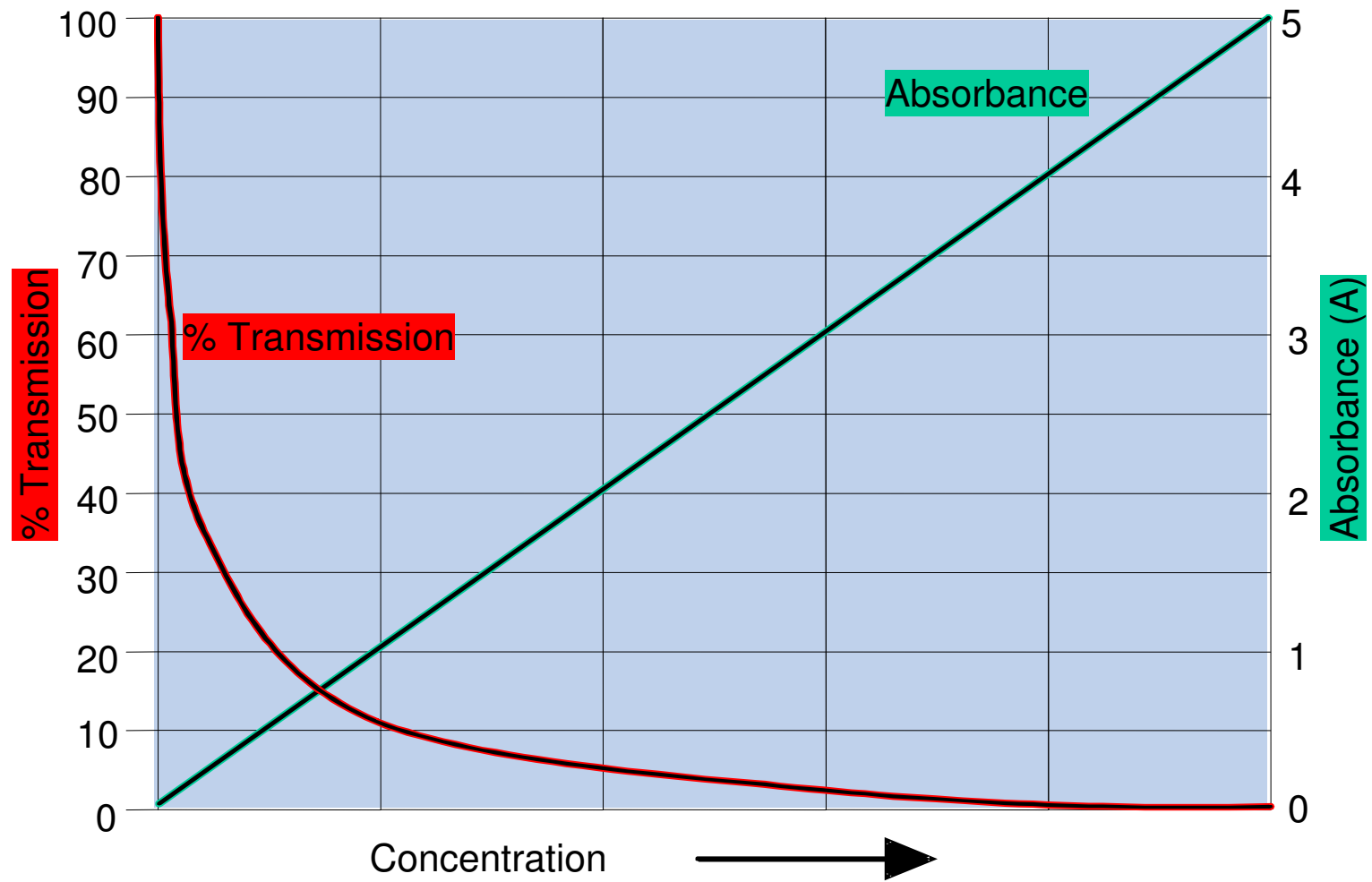
AU: Absorbance Units

CU: Concentration Units
(competitor)

OD: Optical Density

$$OD = A / OPL_{cm}$$

Absorption - Lambert Beer's Law III

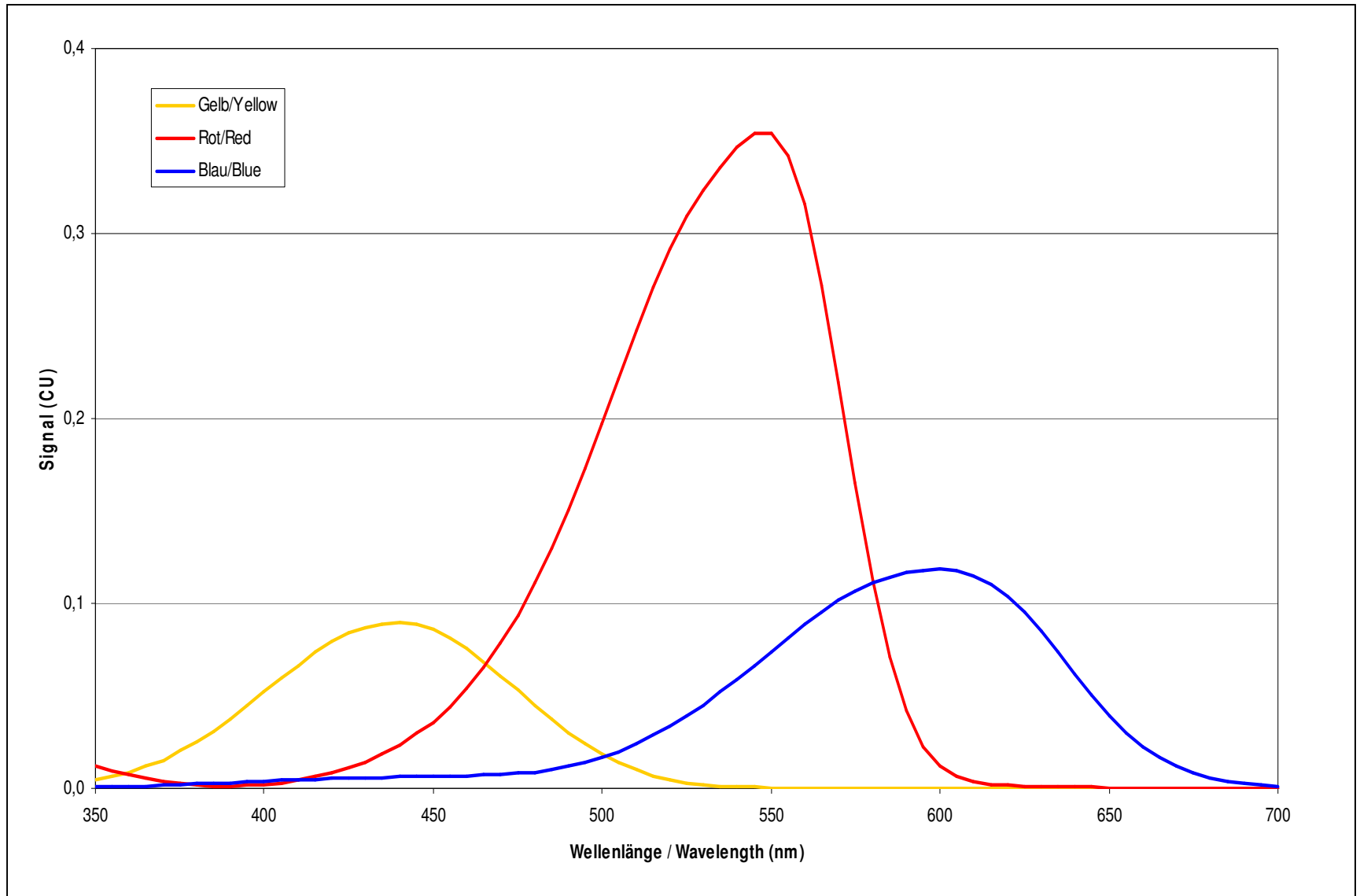


Absorption - Lambert Beer's Law IV

$$A = -\log T$$

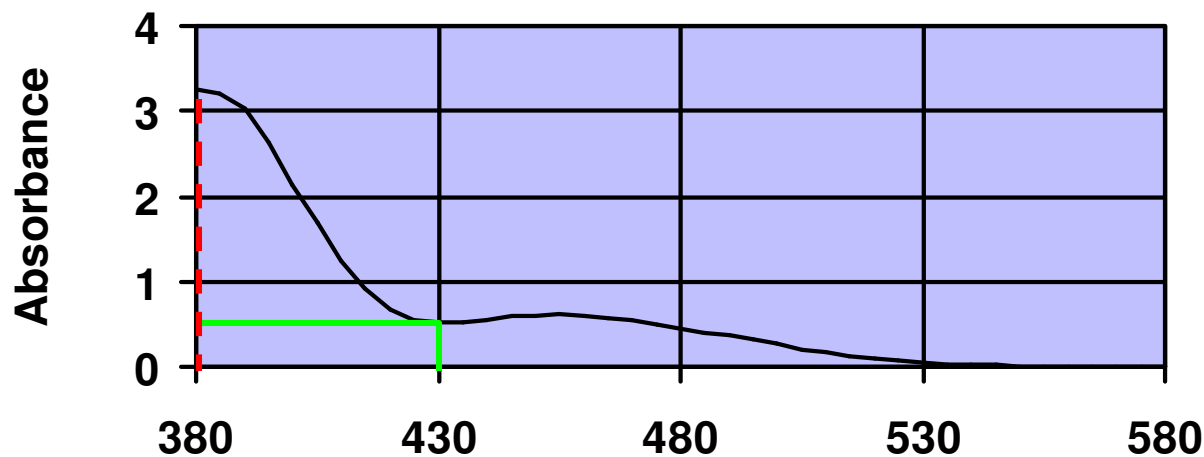
Absorbance (CU)	Transmission (%)
0	100
0,5	32
1	10
2	1
3	0,1
4	0,01

Absorption - Different Colors

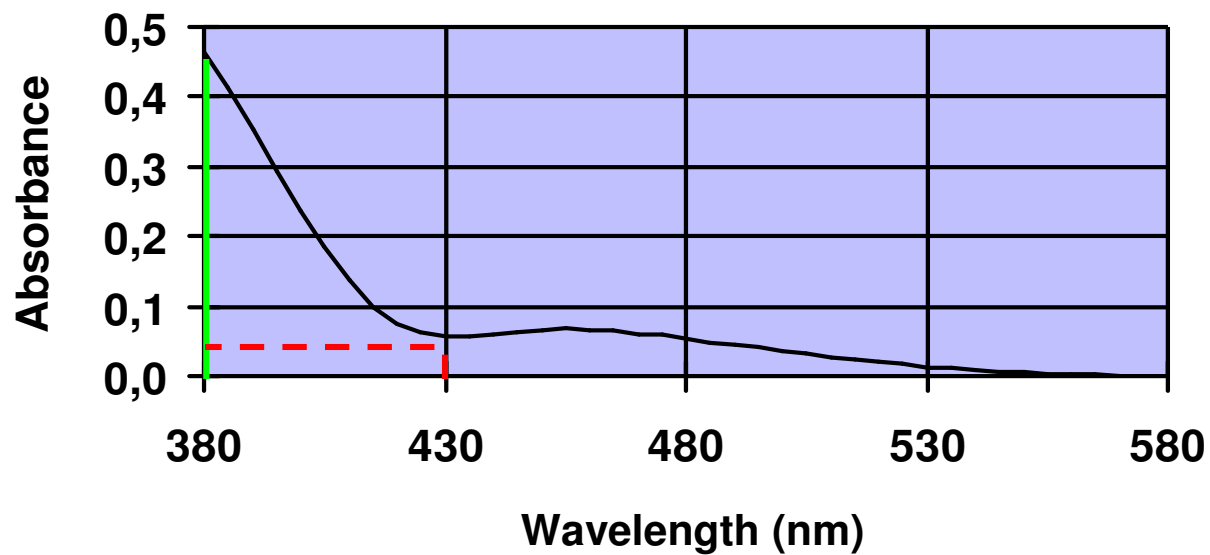


Color Analysis, e.g. APHA

500 APHA
5 cm cuvette

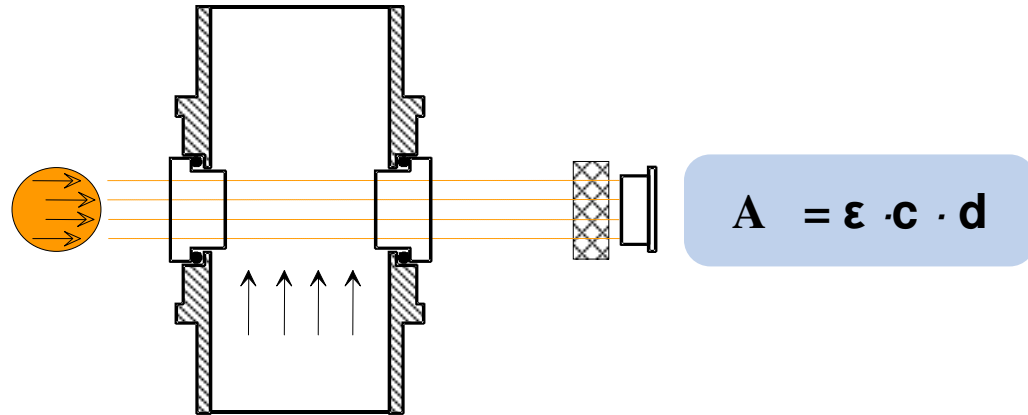


50 APHA
5 cm cuvette

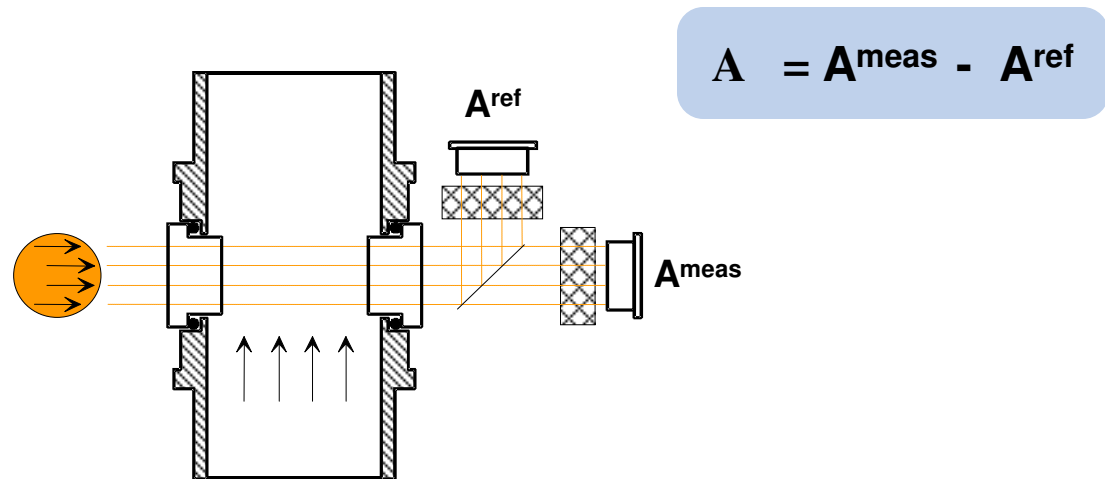


Color Analysis

Single Beam Absorption:

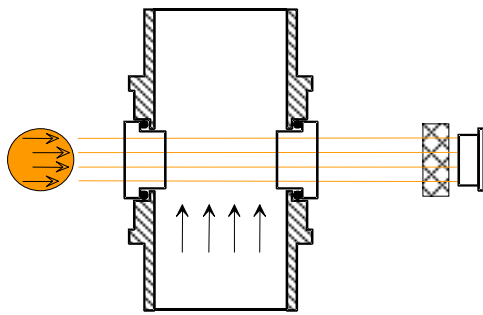


Dual Beam Absorption:



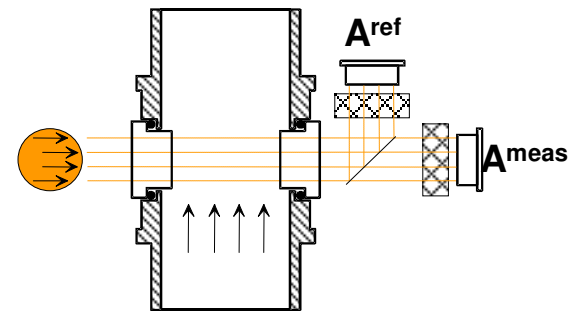
Color Analysis - Comparison Single and Dual Beam

Color Intensity



Single Beam Absorption:

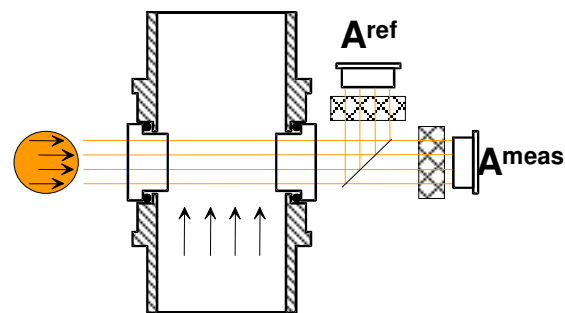
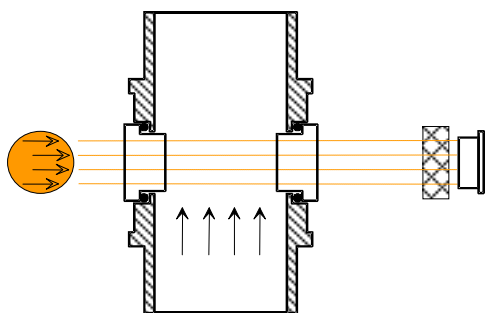
- No Turbidity
- No Bubbles
- Significant color changes



Dual Beam Absorption:

- Compensation of turbidity
- Compensation of bubbles
- High sensitivity
- Compensation of lamp aging

Color Analysis - Typical Apps Single and Dual Beam



- **Phase separation:**

- Beer / Water
- Wine / Water
- Juice / Water
- Hemoglobin concentration in blood

- Color dosage
- Quality control / Purity (absence of color)
- Decolorization control
- Color scales: APHA, Hazen, EBC, ASBC, ASTM, ICUMSA, Lovibond
- Concentration of inks / colorants
- Residual color in waste water
- Metals in solution: Iron, copper, nickel, chromium
- Humic matter in drinking water
- Chlorophyll in edible oil
- Bleaching of edible oil, sugar syrup...
- Lignin in hydrosulfuric acid
- Dissolved water in organics
- Phase separation: organic and aqueous phase
- Chlorine / chlorine dioxide / hypochlorite

Color Analyzer Manufacturers

- Ametek Process Instruments Model 4000
- Galvanic Applied Sciences Monitek Monispec AD
- Optek Model AF26
- Sigrist ColorPlus
- Wedgewood Analytical Model AF21, AF22

Ametek Model 4000



GAS Monitek Monispec AD



Optek Control 4000/AF26



Sigrist ColorPlus



Wedgewood Analytical 980/AF21,AF22

