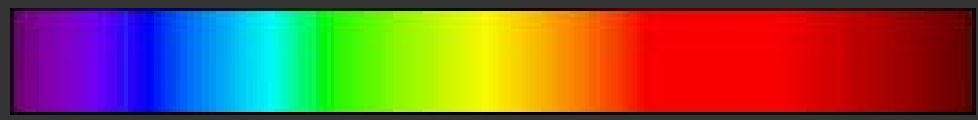
Radio- and photometric quantities

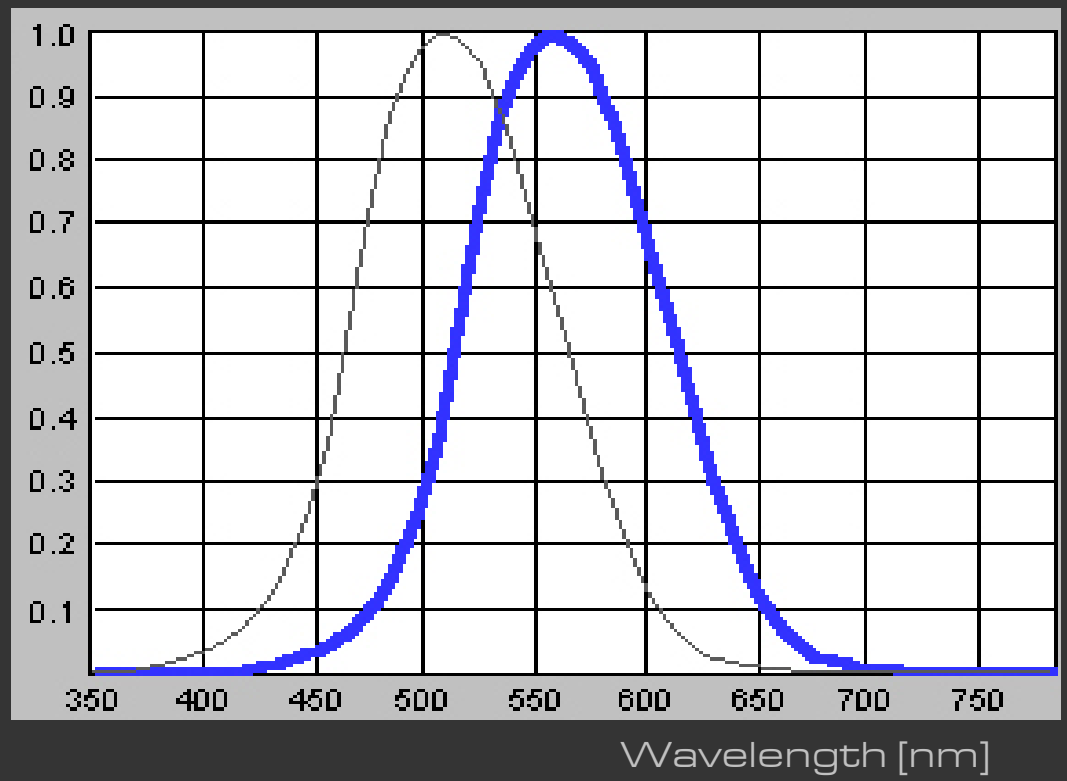
- Radiometry vs. Photometry
  - absolute (energy)

vs.

  - V(λ)-dependent (light)

  - Perceived brightness different from actual light output !





Radio- and photometric quantities

- Four major quantities
  - flux
  - illuminance
  - intensity
  - luminance

Radio- and photometric quantities

- Flux
  - energy / unit of time
  - ϕ in Watts [W] vs. lumen [lm]

Radio- and photometric quantities

- Flux
- Illuminance
  - flux received / unit of surface
  - E in [W/m^2] vs. [lm/m^2] or lux [lx]

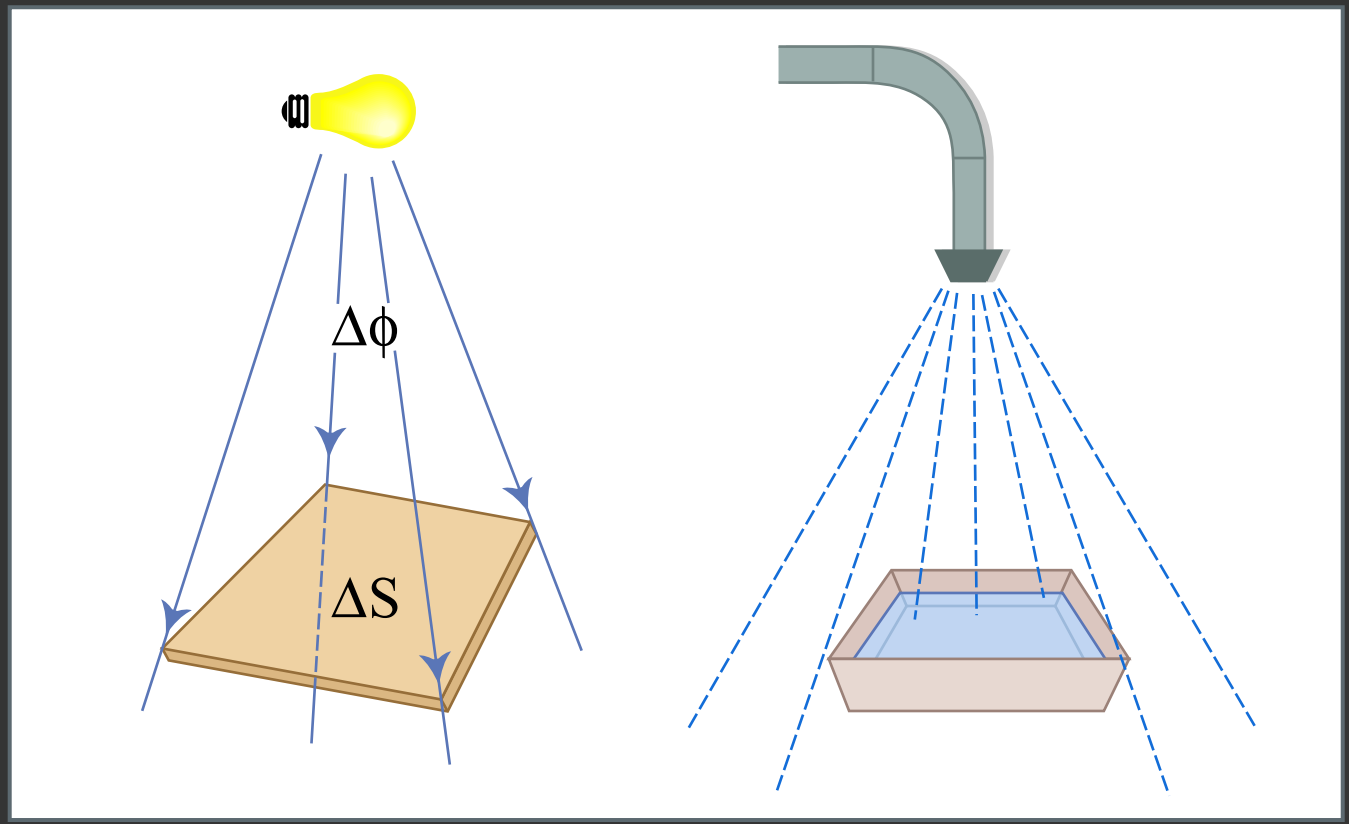


Figure by MIT OCW.

Radio- and photometric quantities

- Flux
- Illuminance
  - flux received / unit of surface
  - E in [W/m^2] vs. [lm/m^2] or lux [lx]

Full moon	Overcast sky	Sunlight
0.01 lux	8'000 - 20'000 lux	100'000 lux

Radio- and photometric quantities

- Flux
- Illuminance
  - flux received / unit of apparent surface (cosine ("Lambert") law)
  - E in [W/m^2] vs. [lm/m^2] or lux [lx]

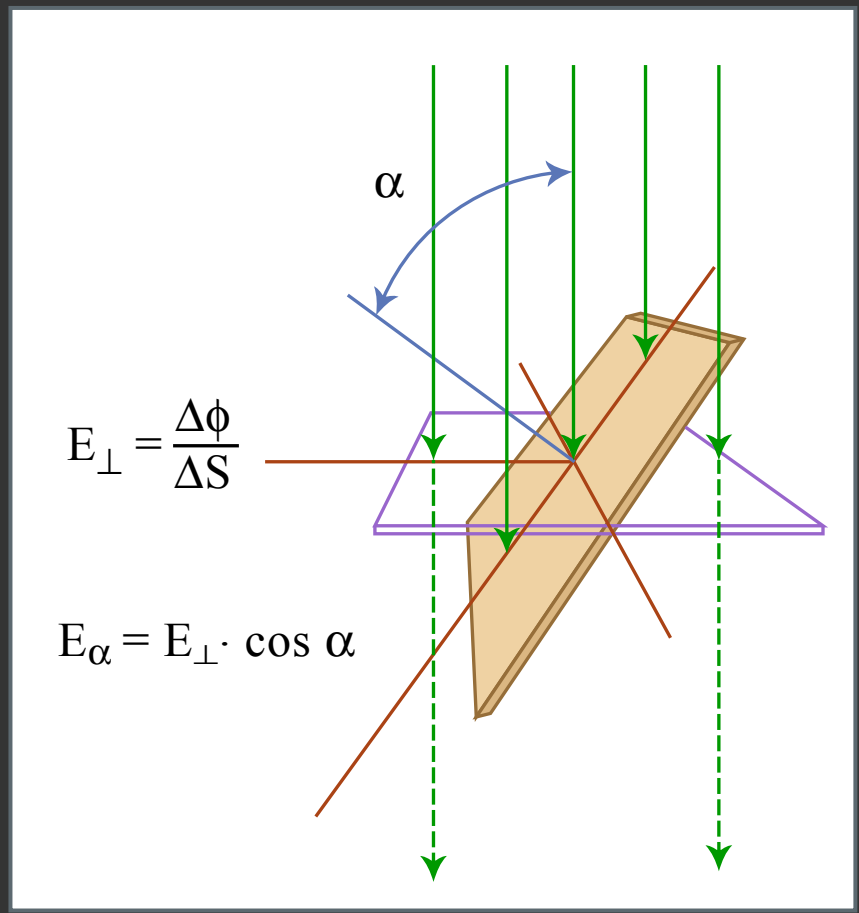


Figure by MIT OCW.

Radio- and photometric quantities

- Flux
- Illuminance
  - flux received / unit of apparent surface (cosine ("Lambert") law)
  - E in [W/m^2] vs. [lm/m^2] or lux [lx]
  - measurement with lux-meter (illumance-meter)

Requirements	Lux	Examples
Low	20-70	Circulation, stairs
Moderate	120-185	Entrance, restaurant
Medium	250-375	General tasks
High	500-750	Reading, Writing
Very high	> 1000	Precision tasks

Radio- and photometric quantities

- Flux
- Illuminance
- Intensity
  - flux emitted "in a certain direction"

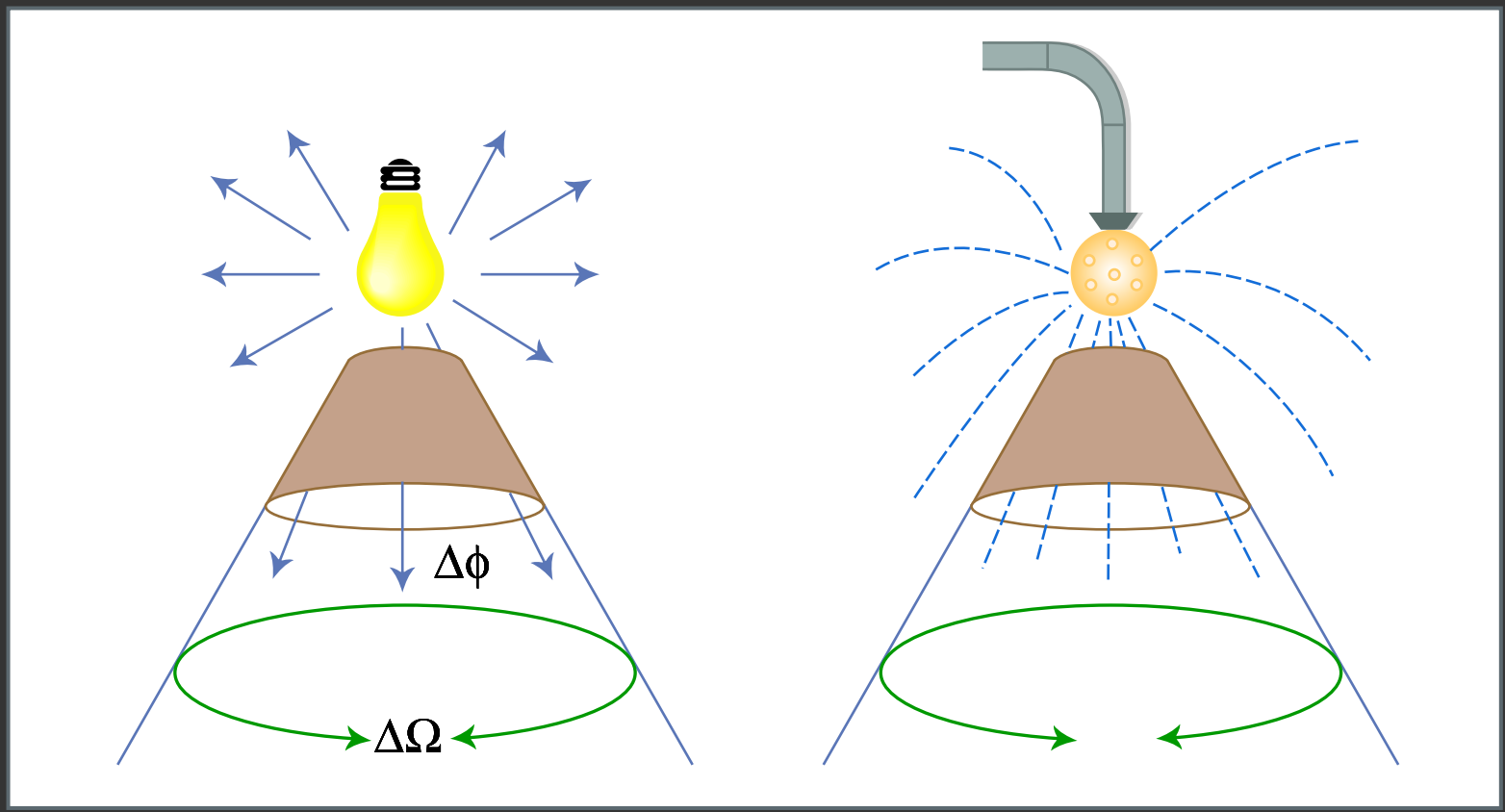


Figure by MIT OCW.

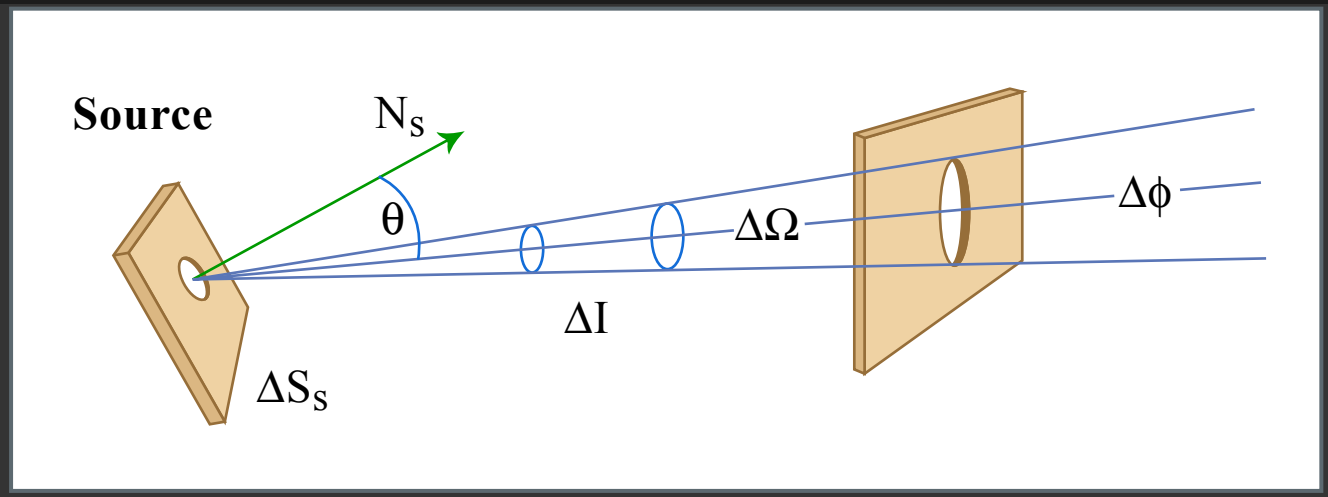
Radio- and photometric quantities

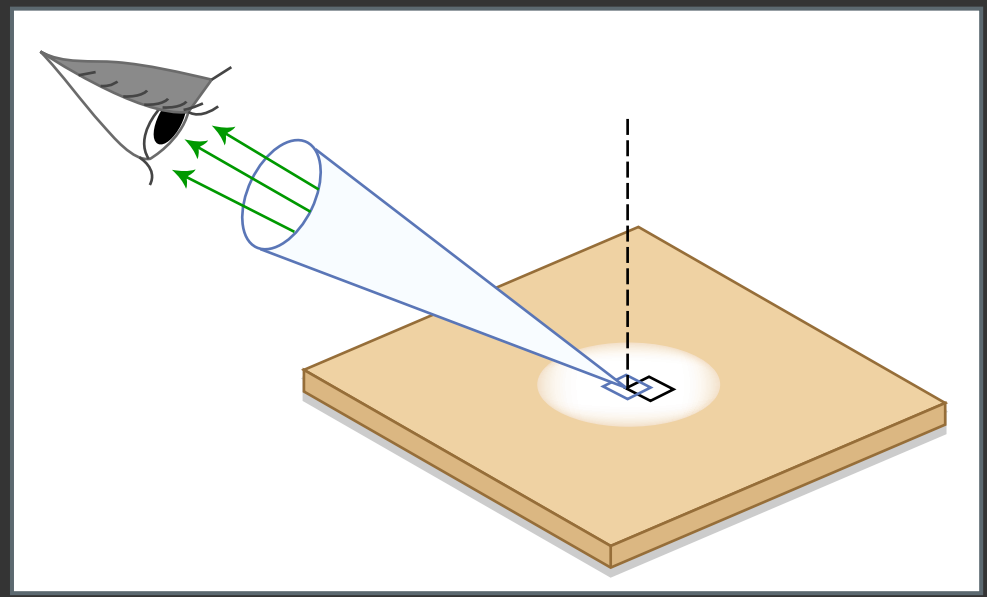
- Flux
- Illuminance
- Intensity
  - flux emitted within a certain solid angle
  - I in [W/sr] vs. [lm/sr] or Candela [Cd]

1 Candela = intensity of one candle

Radio- and photometric quantities

- Flux
- Illuminance
- Intensity
- Luminance
  - flux emitted by apparent surface in a given direction
  - ≈ I/m² (or M/sr)
  - L in [Cd/m²]

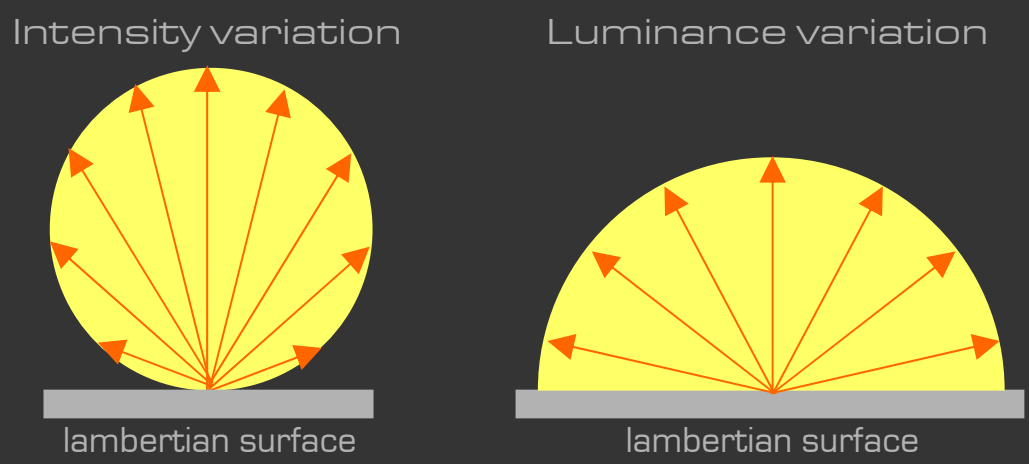




Figures by MIT OCW.

Radio- and photometric quantities

- Flux
- Illuminance
- Intensity
- Luminance
  - flux emitted by apparent surface in a given direction
  - ≈ I/m^2 (or M/sr)
  - L in [Cd/m^2]



Radio- and photometric quantities

- Flux
- Illuminance
- Intensity
- Luminance
  - flux emitted by apparent surface in a given direction
  - ≈ I/m² (or M/sr)
  - L in [Cd/m²]

Primary sources	Cd/m²
• Sun	1 650 000 000
• Incandescent lamp (100 W, bright)	6 000 000
• Incandescent lamp (100 W, frosted)	125 000
• Fluorescent tube (40 W, 38 mm)	5000 - 8000
• Candle	5000
• Computer screen	100-200

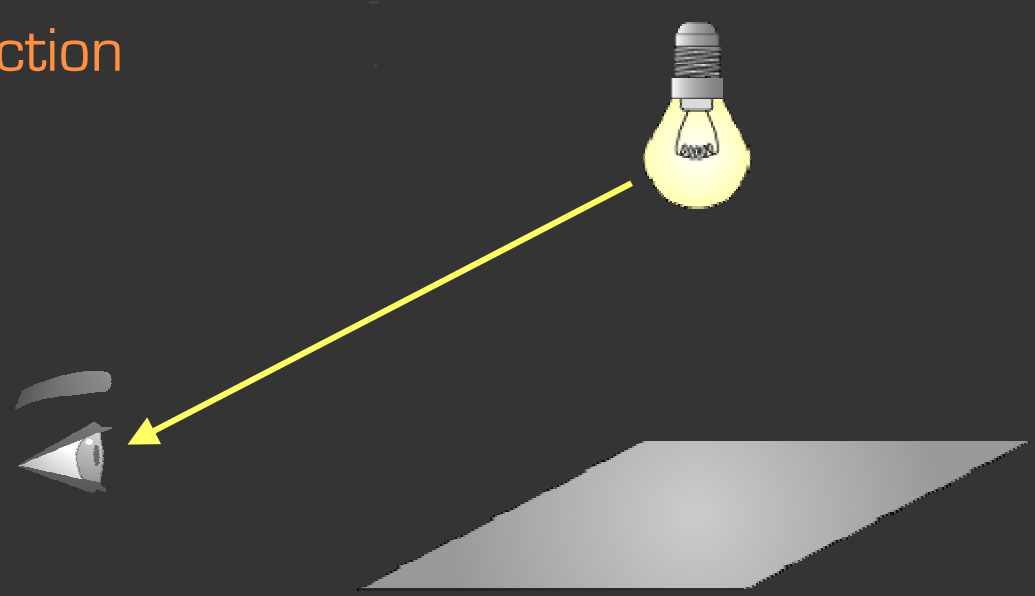


Image courtesy of Prof. B. Paule, Estia SA, Lausanne, Switzerland.

Radio- and photometric quantities

- Flux
- Illuminance
- Intensity
- Luminance
  - flux emitted by apparent surface in a given direction
  - ≈ I/m^2 (or M/sr)
  - L in $[Cd/m^2]$

Secondary sources	Cd/m^2
• Moon	2 500 - 3000
• White paper (ρ = 0.8, E = 400 lux)	100
• Grey paper (ρ = 0.4, E = 400 lux)	50
• Black paper (ρ = 0.01, E = 400 lux)	5
Minimal luminance perceived:	10^{-5}

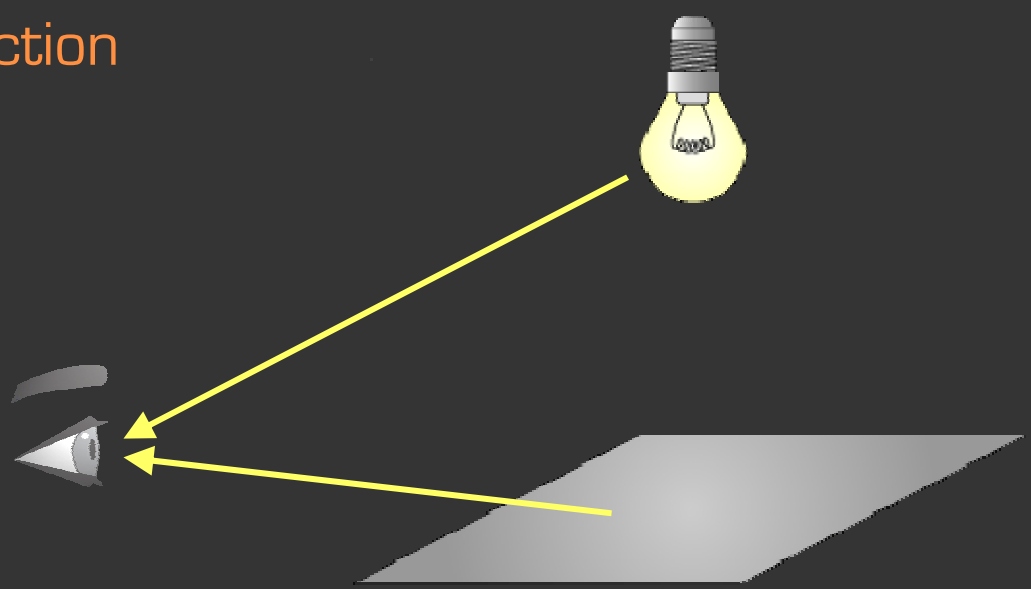
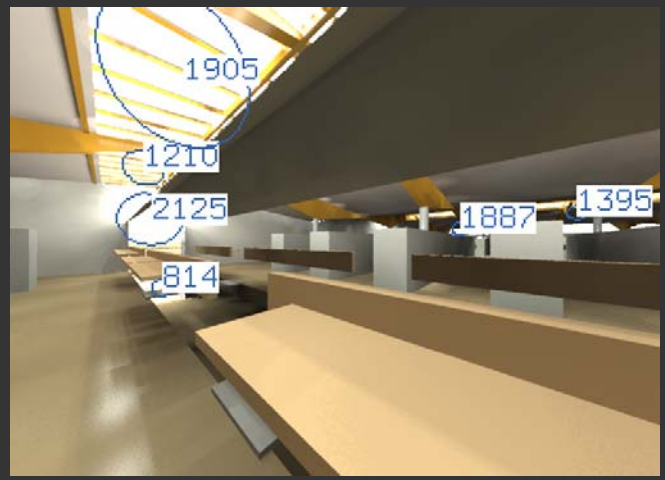


Image courtesy of Prof. B. Paule, Estia SA, Lausanne, Switzerland.

Radio- and photometric quantities

- Luminance measurement
  - Eye = luminance-meter

Image courtesy of Prof. B. Paule, Estia SA, Lausanne, Switzerland.



Daylight Factor

- DF = ($E_{point}/E_{outside\ horizontal}$) * 100%
  - only for an overcast sky !

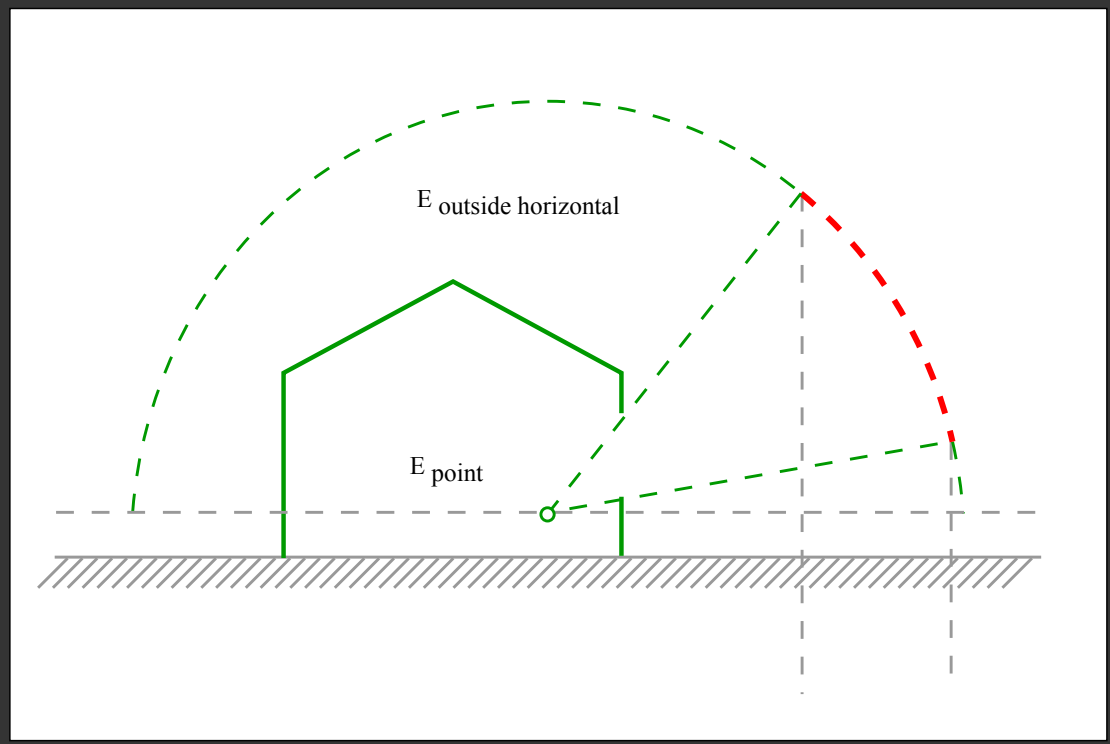


Figure by MIT OCW.

Daylight Factor

- $DF = (E_{point} / E_{outside\ horizontal}) * 100\%$
  - only for an overcast sky !

below 1% → dark, only suitable for storage areas

1% to 2% → low illumination, suitable for circulation areas

2% to 4% → moderate, for living spaces

4% to 7% → medium, for office work

7% to 12% → high, for precision tasks

over 12% → very high, for exceptional light requirements