Lighting for people

Michael Herf, f.lux software

February 2017

A brief history of f.lux

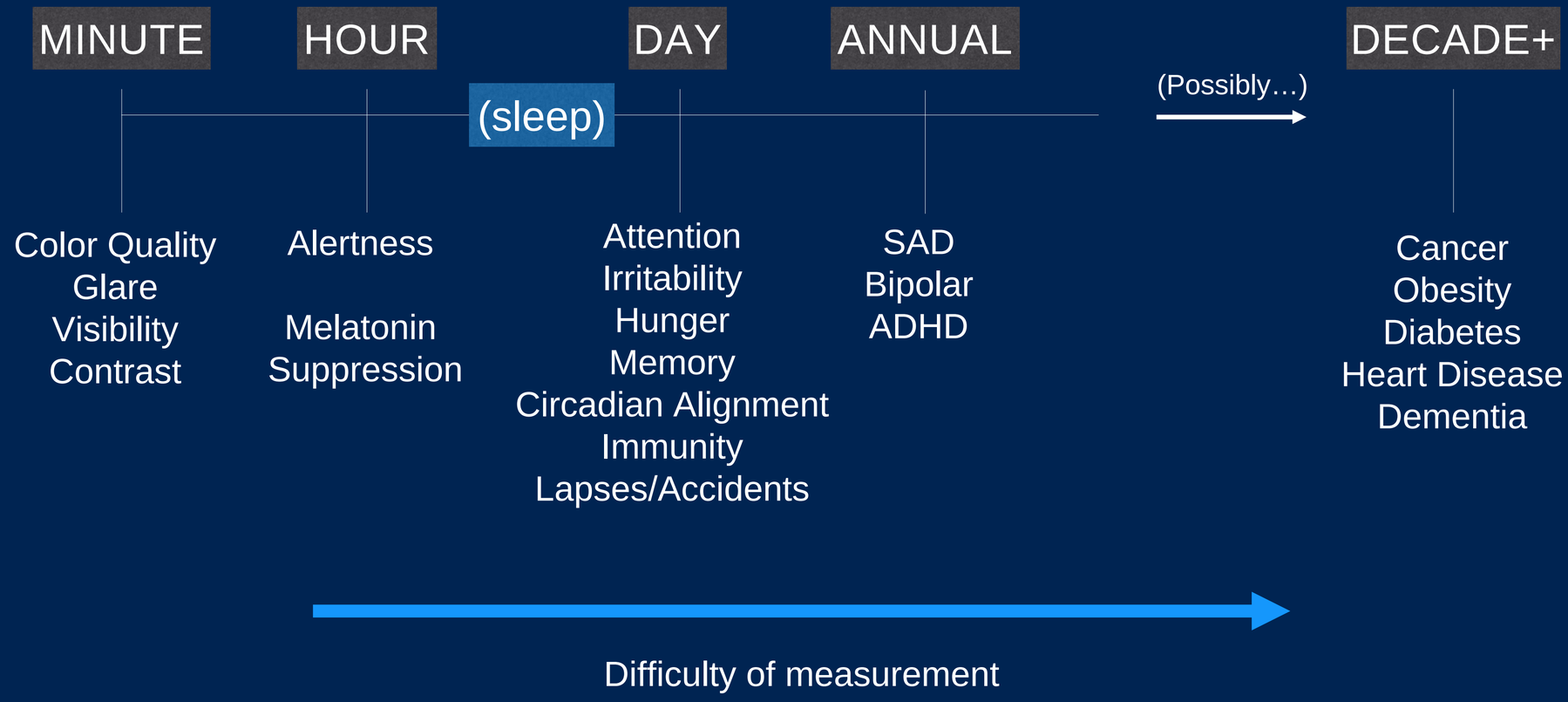
2009: We made light from screens look warm at night, like the room they’re in. Suggested this might affect sleep.

(A million people show up to talk about how light affects sleep.)

2010: We really should understand how the human body processes.

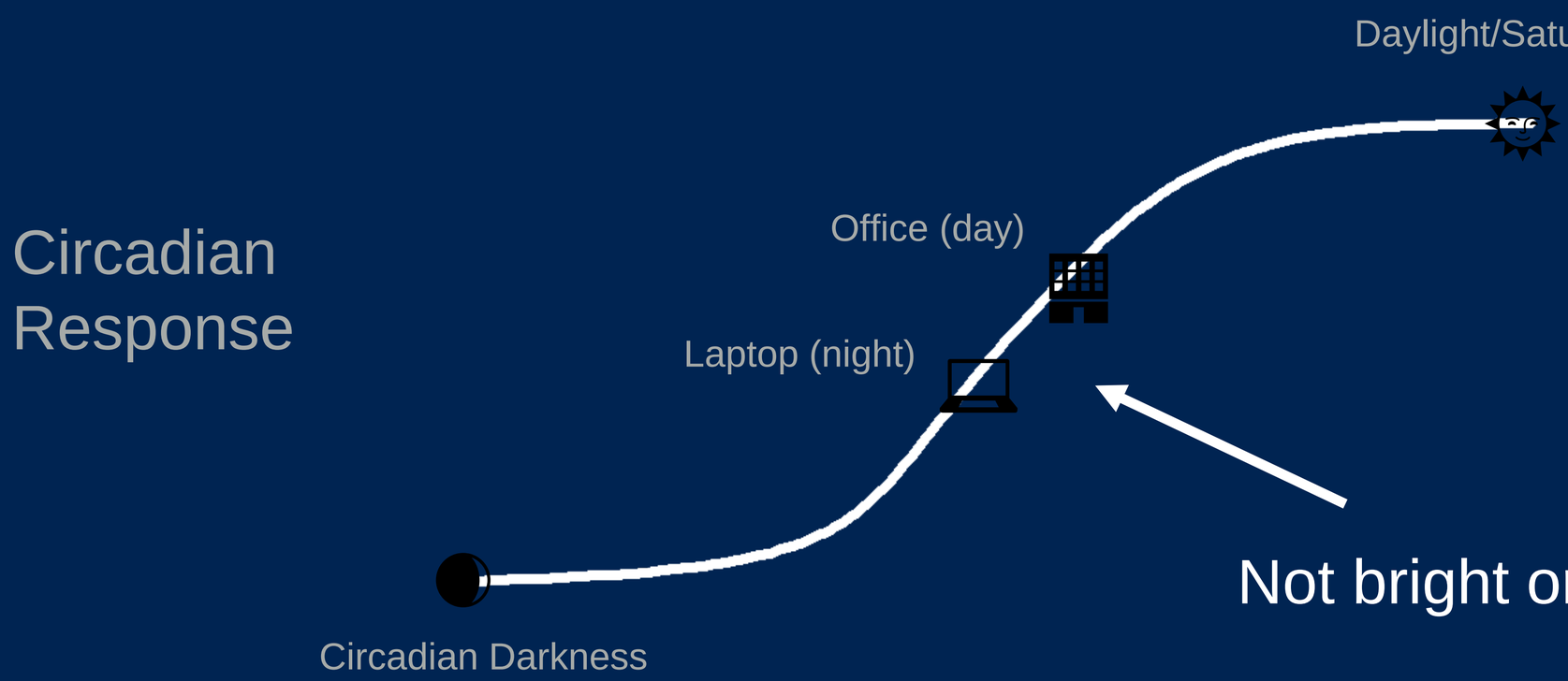
2011: This is way more complicated than we thought.

How light affects us over time



How much light do we need
to signal night vs. day?
And when?

Light levels and response



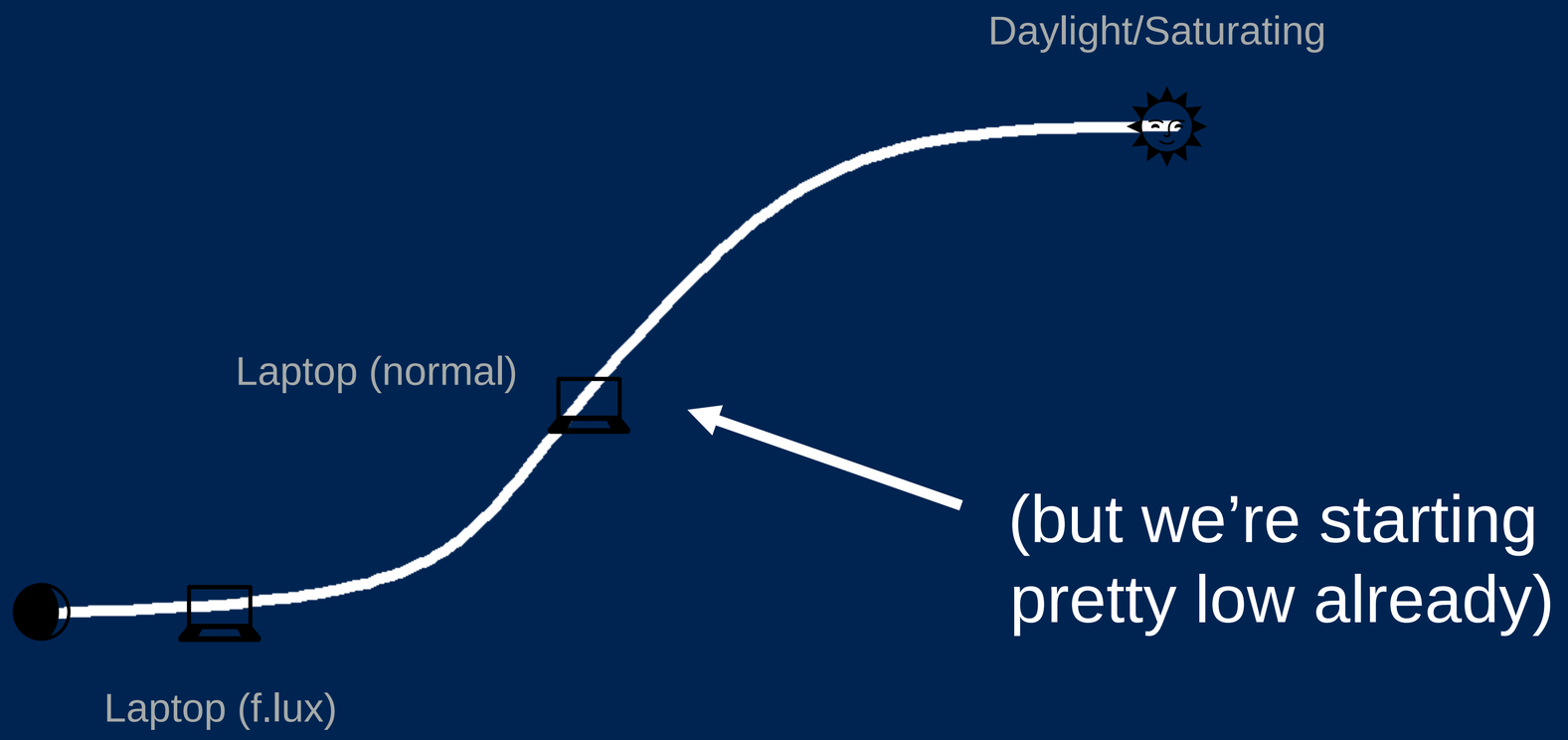
Go read this:
http://bit.ly/2kx6R68

Graph inspired by: Zeitzer, J.M., Dijk, D.J., Kronauer, R.E., Brown, E.N. and Czeisler, C.A., 2000. Sensitivity of the human circadian pacemaker to nocturnal light: melatonin phase resetting and suppression. The Journal of physiology, 526(3), pp.695-702. Vancouver

Circadian dynamic range is >2 orders of magnitude

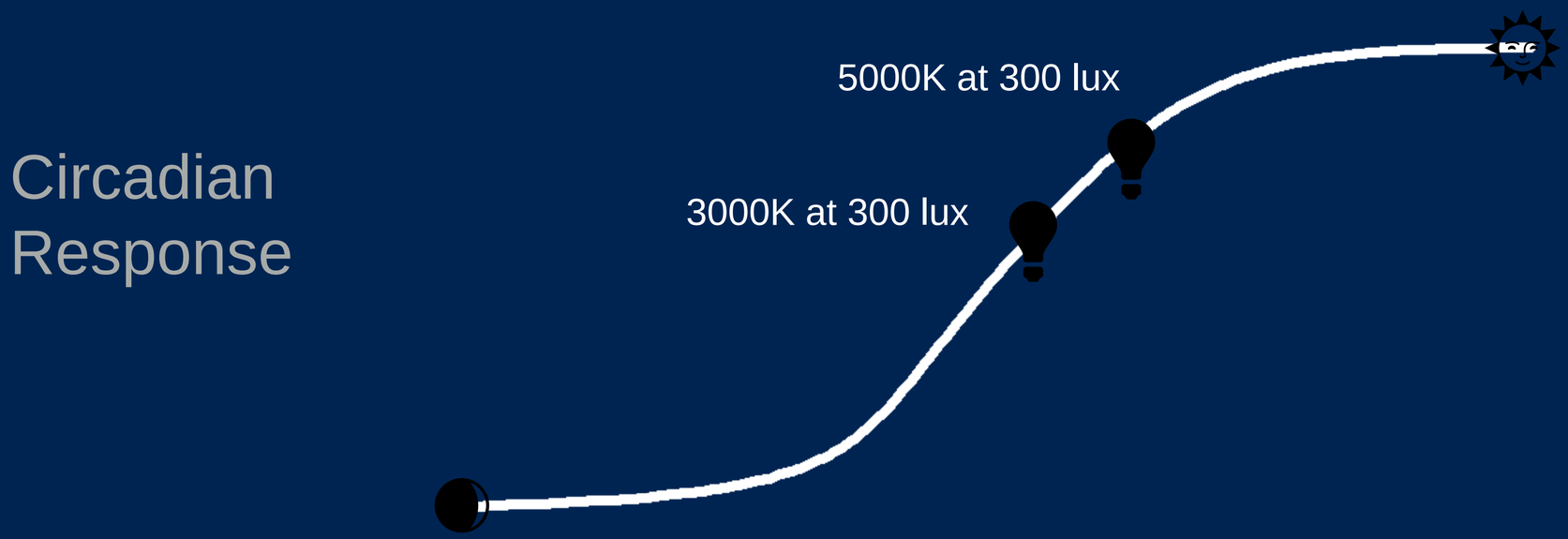
maybe 3.

f.lux removes 80-90% alerting light at night

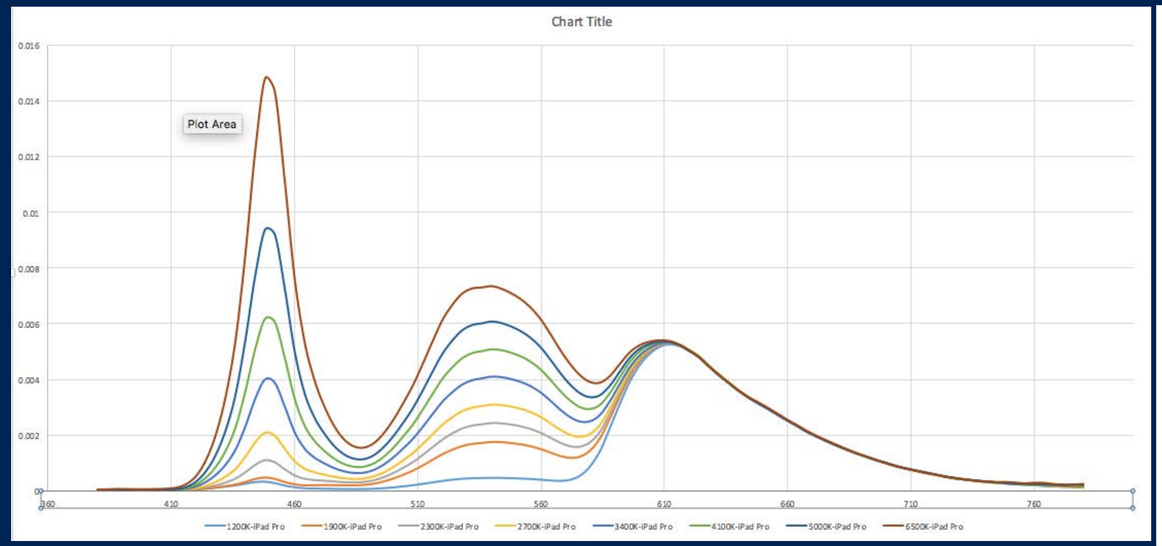


We have to fix the day,
not just the night.

Does constant-lux tuning help?



f.lux is not constant lux



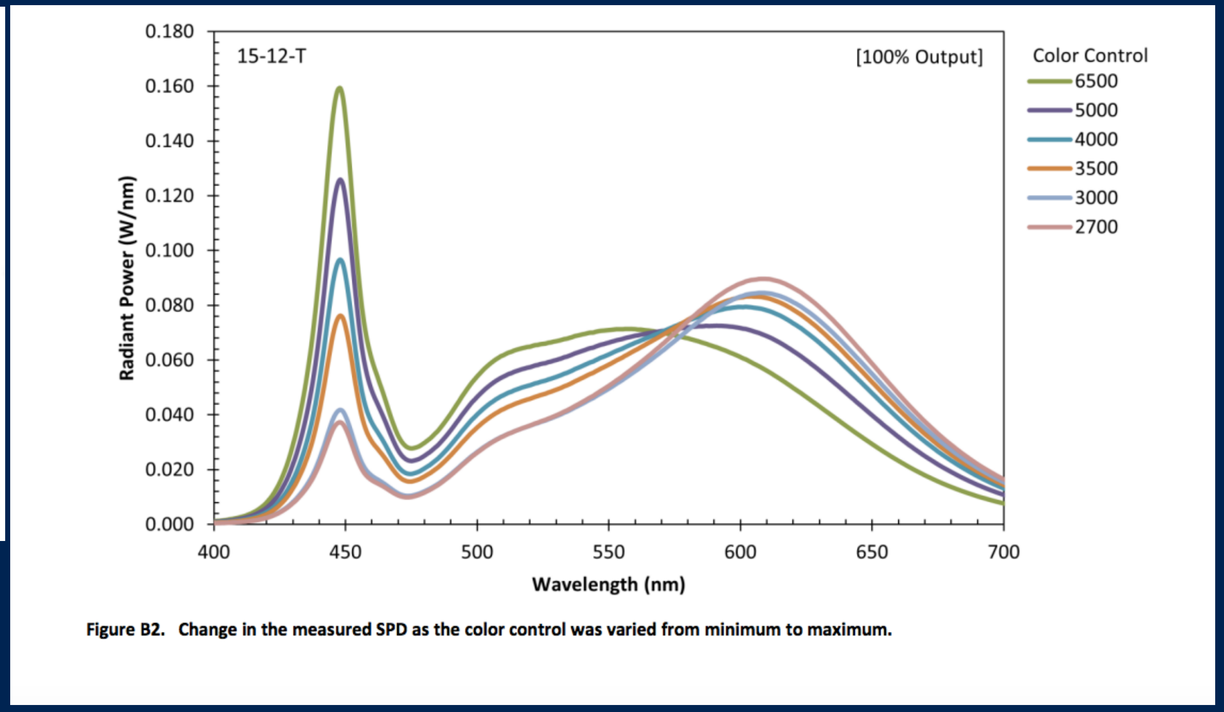


Figure B2. Change in the measured SPD as the color control was varied from minimum to maximum.

f.lux “filter” scaling

Constant-lux tunable (via CALiPER)

Alerting vs. Circadian

- Popular press has embraced the “alerting” effects of light: “No blue light before bed.” But “blue” is not a dose.
- Also, when you say “circadian” you have to talk about timing:
  - Different light for early birds and night owls
  - Different light by age
- Sensitivity varies: children may be >2x more sensitive, and seniors much less so

Colors are not magic.

Maybe your cones are lying?

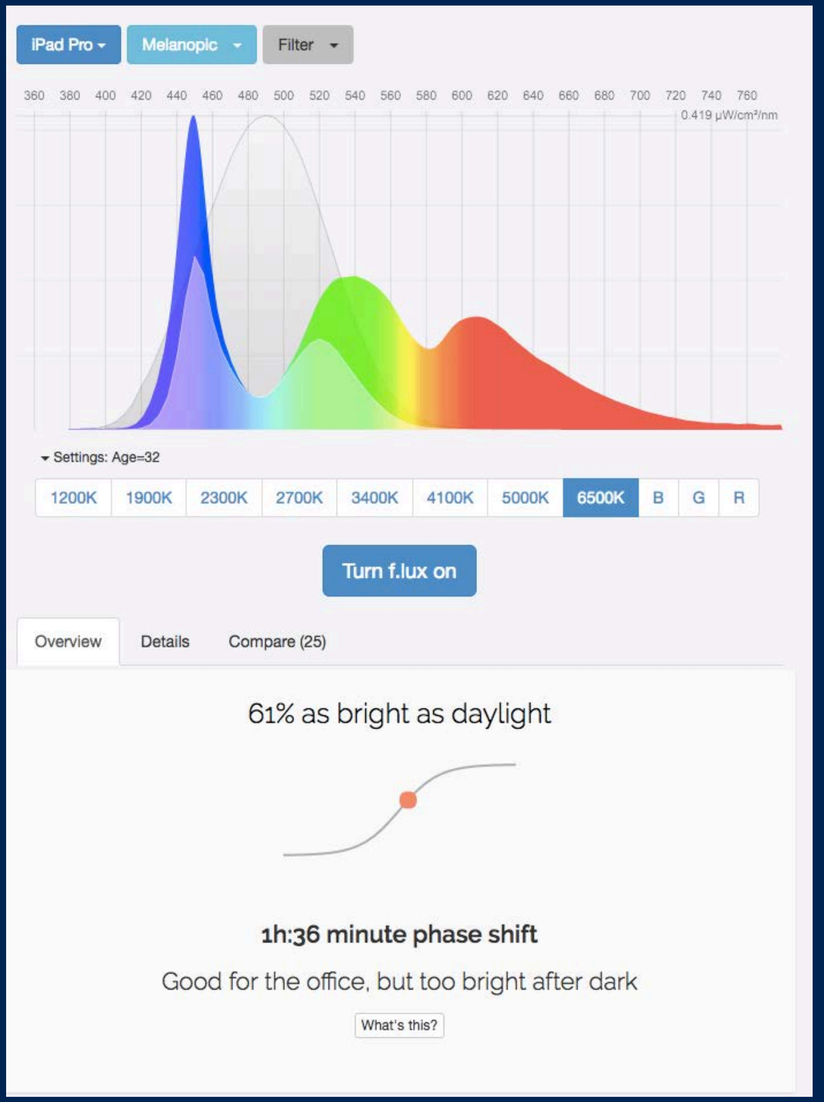
Color vs. Intensity

- A majority of circadian effects are explained by melanopsin acting as a single photoreceptor, sensitive to blue-green light
- This photoreceptor doesn’t say light is “warm” or “cool”—
  that takes two sensors.
- Non-visual response is mostly about how much blue-green light there is. It varies a lot by CCT, but less than most people think.

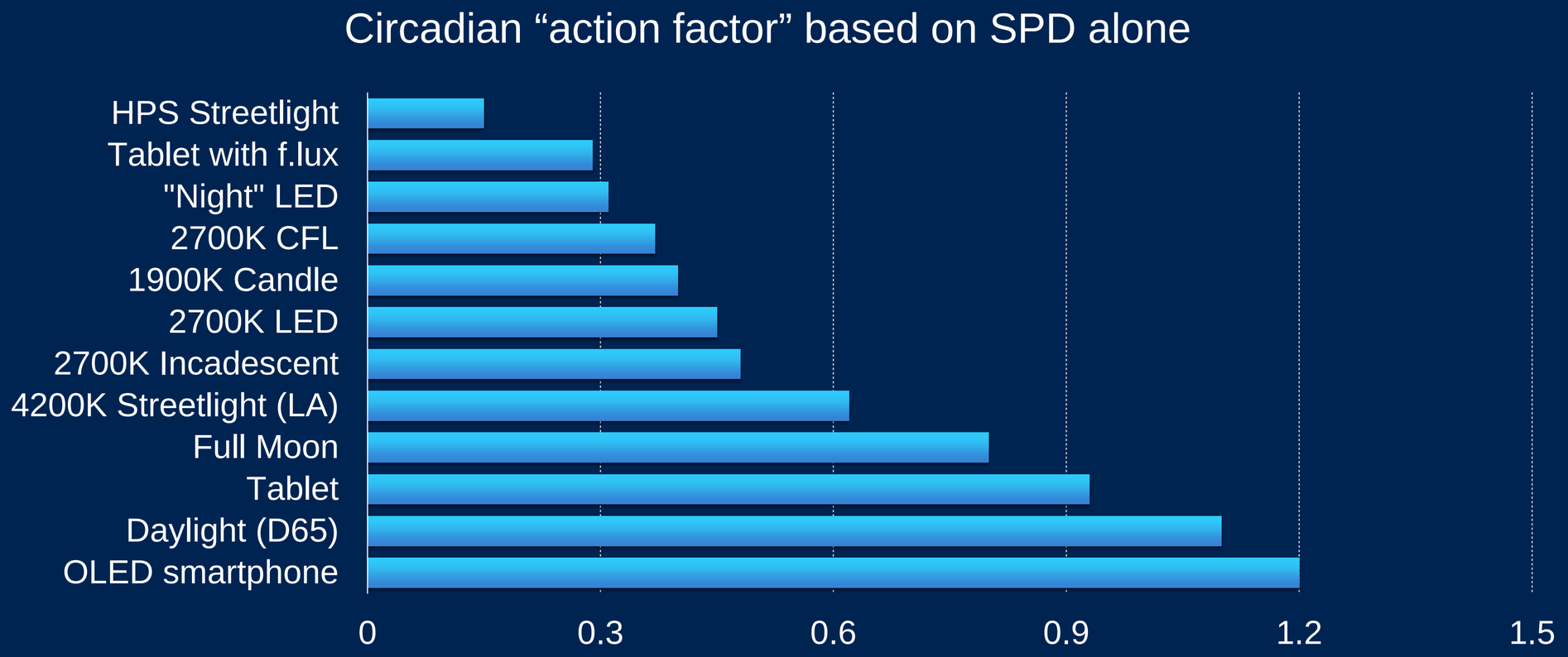
f.luxometer

How spectrum and intensity contribute to circadian responses

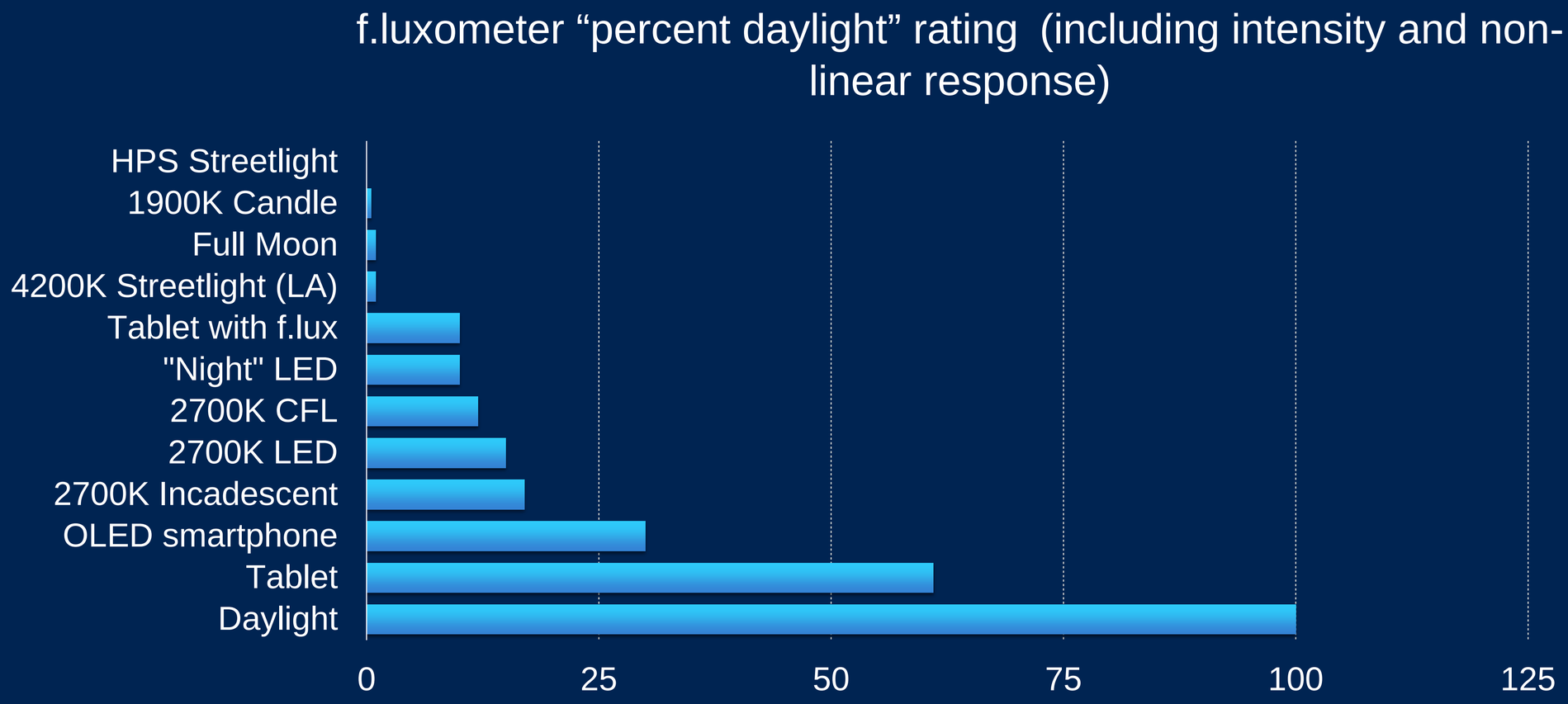
fluxometer.com/rainbow/



M/P ratios (Melanopic/Photopic)



Predicted Effect in Real Life

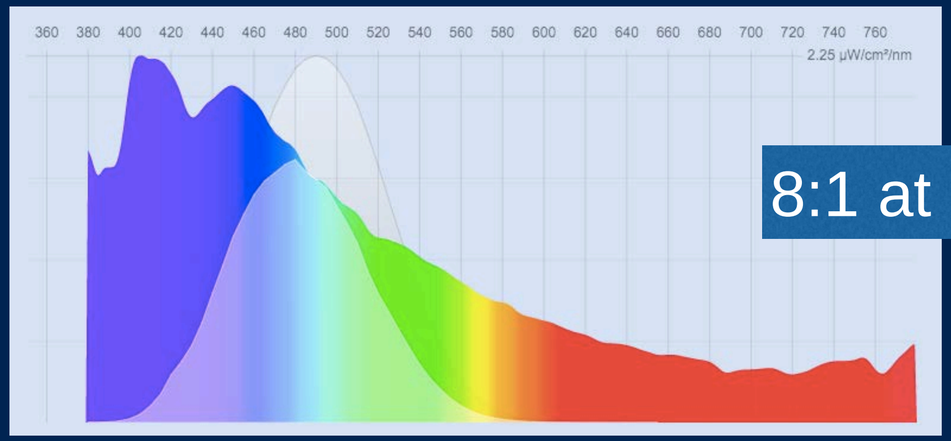


Let’s think log, not linear.

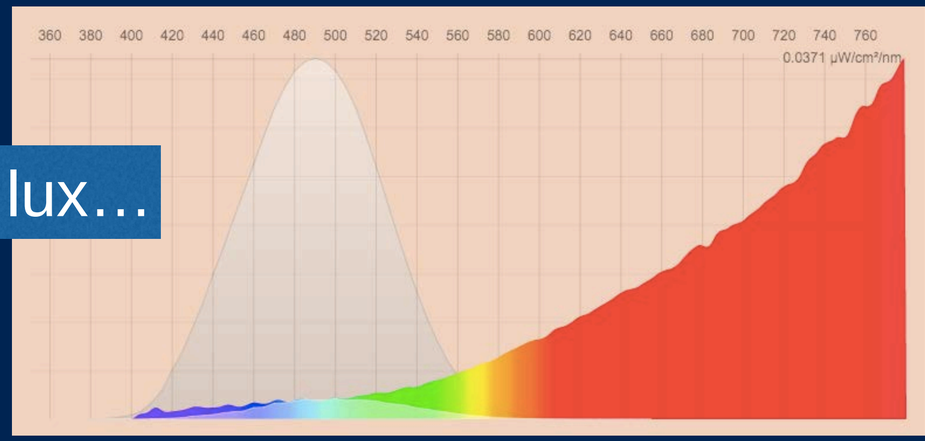
- 20-40% change is good for energy, but this is **small** for a system expecting 100:1 contrast
- Outdoors we even see >100,000:1 contrast from day to night
- 😒 Many “tunable” LED schemes today only manage *1.5:1.*
- How do we get to 100:1, or even 10:1?

Ways to achieve contrast

- Adjust intensity as much as you can. Fade really slowly.
- Find ways to do more with spectrum:



8:1 at constant lux…



Sky in Los Angeles
51,000K, 1.7 M/P ratio, no glare

Wood fire
1500K, 0.2 M/P ratio, R9=romantic

Changing over time

- The body doesn’t do as well with a random schedule
- The sun sets without asking first
- Nobody is evolved to change scenes or dim lights at the right time
- So, automate it, with manual override

Watts vs. Zzzs

- Opportunities to optimize energy
  - Blue-enriched light during the day can be very efficient
  - Dimming at night helps, especially at the right time

Metrics: Melanopic Only?

- “Melanopic lux” is a good start, supported by the research:
  - When light is bright
  - When light is not changing
  - For long exposures
- Need adjustments (2x for age, light history), but gets close to human response

When is melanopic lux less reliable?

- 🌩️ The cones (and rods) may be involved when:
  - Colors and intensity are changing
  - Exposure times are short
  - Light is dim
- □□ Considerations in “minimizing” melanopic spectrum:
  - Night vision (overlaps with rods)
  - Also minimizes pupil response

Thank you.

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