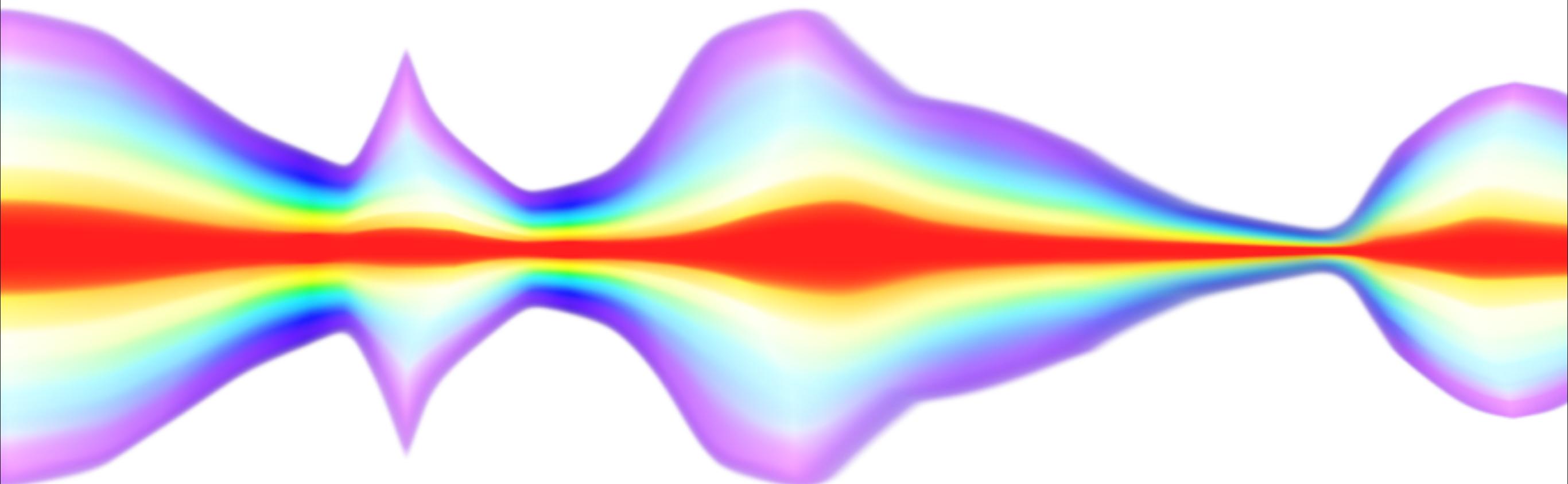


Light Log

Brighten your day

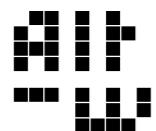


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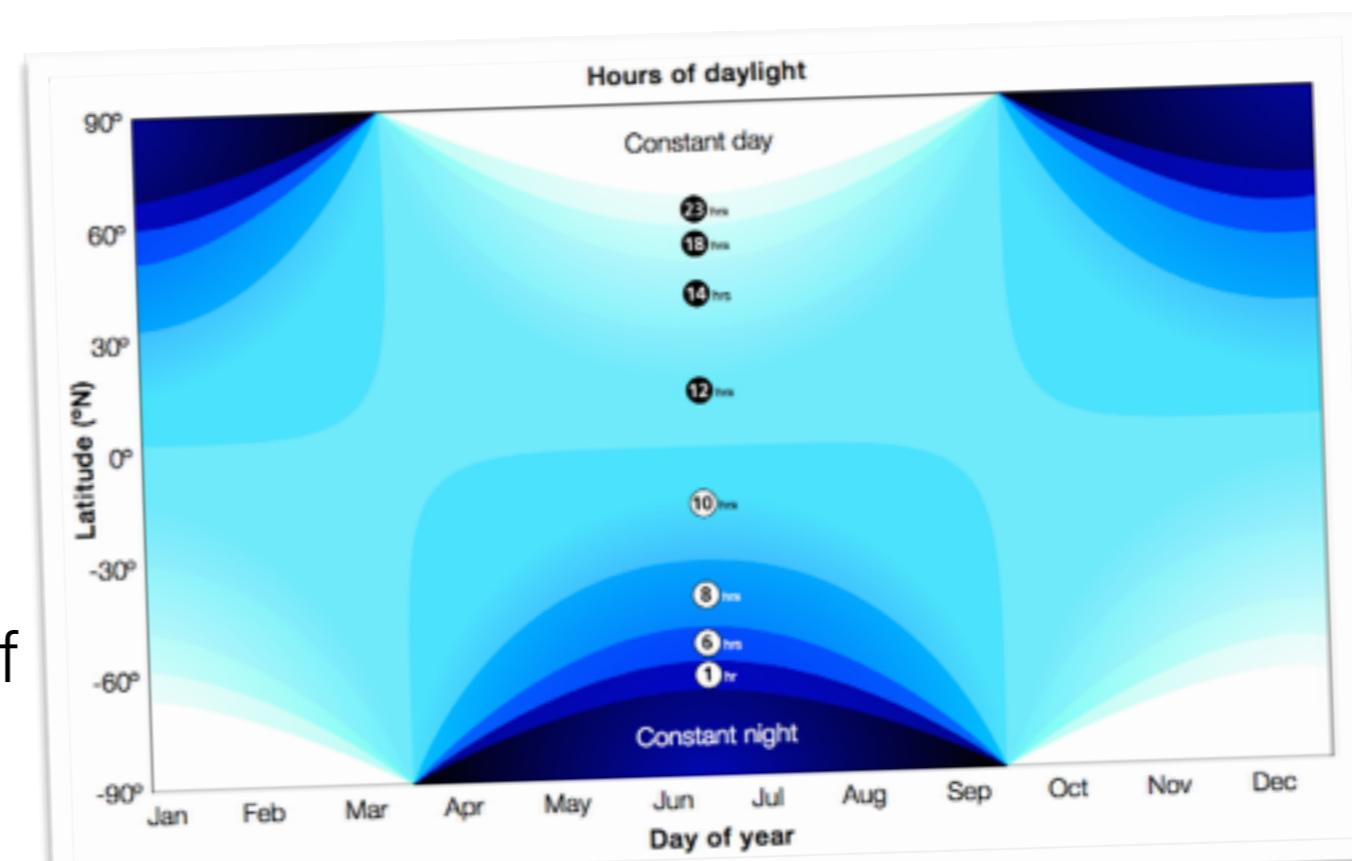


Supported by New Media Scotland's Alt-w Fund with investment from the Scottish Government.

Introduction

- What is Light Log?
 - Continuous, ambient light recording device
 - Wearable
 - Low cost (~£10 BOM)
 - Tangible device
 - Physical computing
 - Open Source, Open Hardware

- Who is it for?
 - Those affected by Seasonal Affective Disorder
 - “Thought to be linked to reduced exposure to sunlight during the shorter days of the year” –NHS Choices
 - 2 million people in the UK (12 million in Northern Europe)
 - Winter Blues (Sub-syndromal Seasonal Affective Disorder)
 - Up to 20% of population (SAD Association)
 - Light sensitivity
 - Medication
 - Medical conditions
 - Health and wellbeing
 - Vitamin-D light exposure
 - Life-logging, Quantified Self



- Why log light?
 - Allows the wearer to monitor & modify behaviour
 - Improve sleep quality
 - Sleep disrupted by more serious conditions
 - Alzheimer's disease, Parkinson's disease
 - Improve energy levels / alertness
 - Vitamin-D light exposure
 - Manageable quantity of data
 - Data suitable for machine learning, auto tagging
 - Minimal impact on other individuals privacy

- How does it help?
 - Easy & objective automatic recording of light
 - Minimal user interaction needed
 - Provides visualisation to promote +'ve behaviour
 - Reach daylight goal exposure
 - Minimise light pollution prior to sleep
 - Other... (events, vitamin-D, outdoor activity)
 - Allows user to compare their data with others
 - Provides data for further research

Project scope

- Development of a prototype Light Log device
 - Involve Makers and Maker communities
 - Developing UI for wearers to interact with their data
 - Integration with Project Ginsberg platform

“Our aim is to help people access information, understand themselves better, track their experience and wellbeing over time, learn how to reinforce positive activities and connect with others.” –Project Ginsberg
- Building 100 units for community outreach (2014 Q1)

Consumer device space

- Nike Fuelband
- Jawbone UP
- Fitbit
- Polar Loop
- Shine
- Memoto/Narrative
- Scanadu



Light related devices

- Dimesimeter, (Rensselaer Institute)
- Daysimeter, (Rensselaer Institute) [1]
- Light and Mood Log (Olga Panades)

<http://www.olgapanades.com/projects/light-and-mood-log/>



- Sensing the Sun through Vibration (Olga Panades)

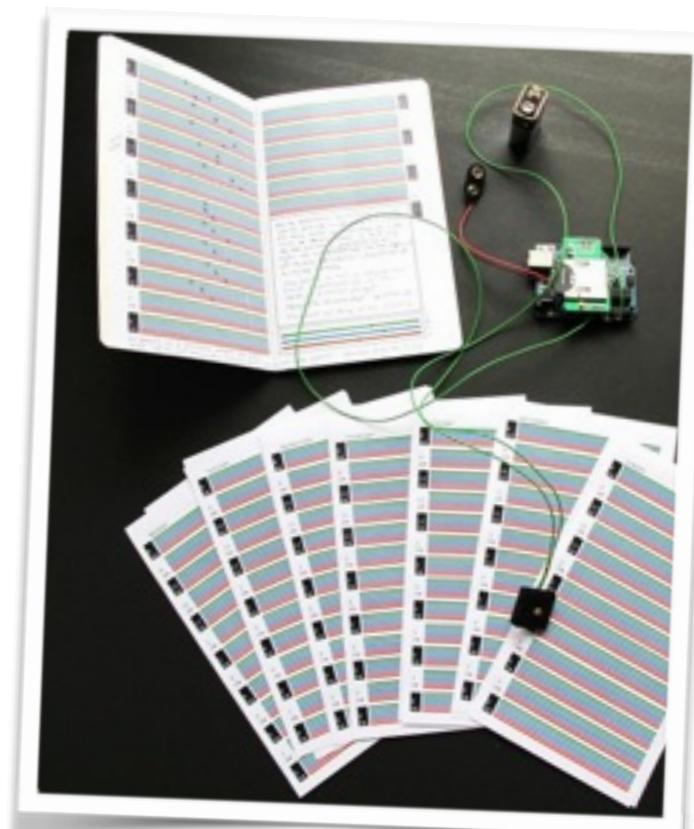
<http://www.viralprojects.com/?p=284>

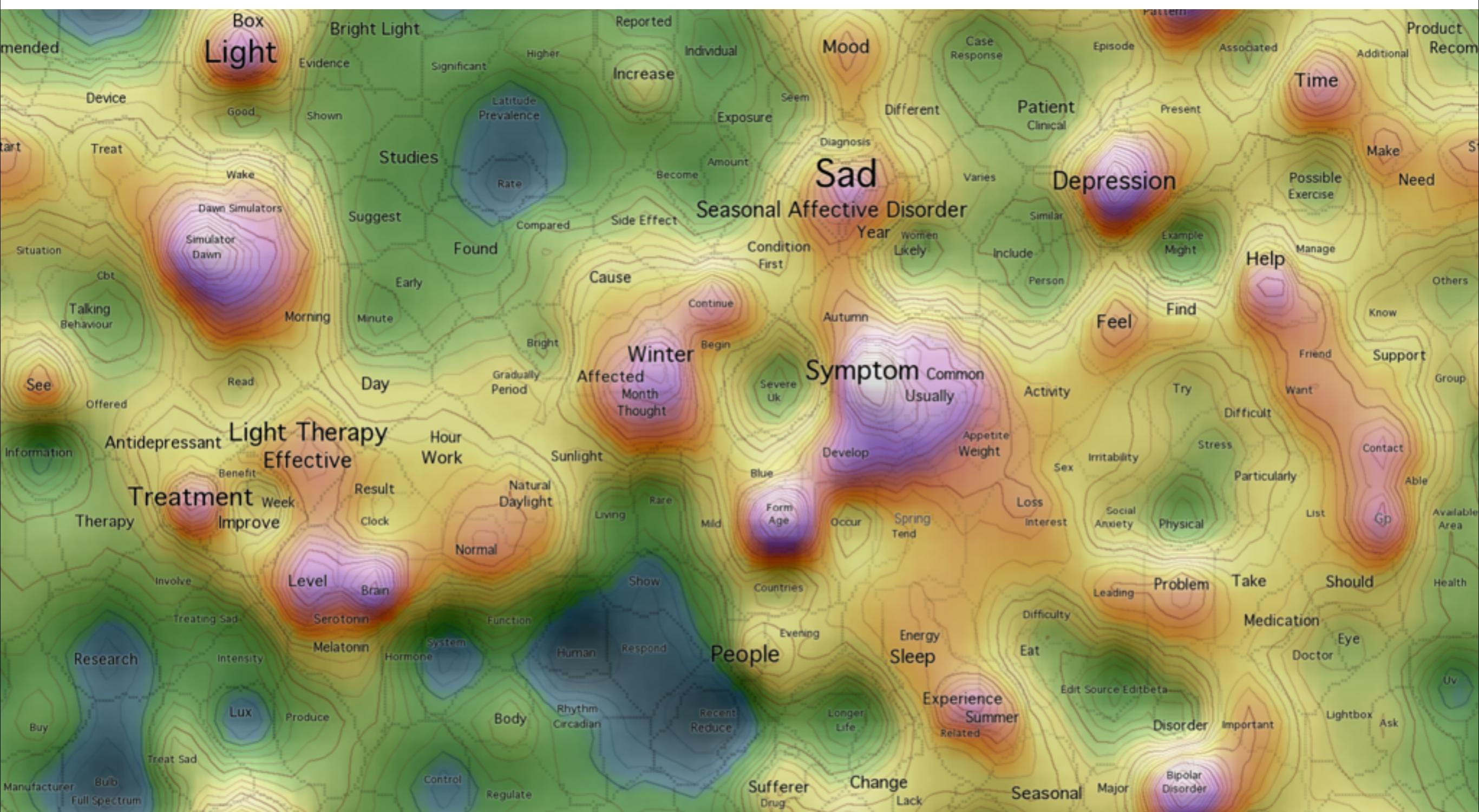
- Citizen Sensor (Joe Saavedra)

<http://portfolio.jmsaavedra.com/selected/modularneuroid/>

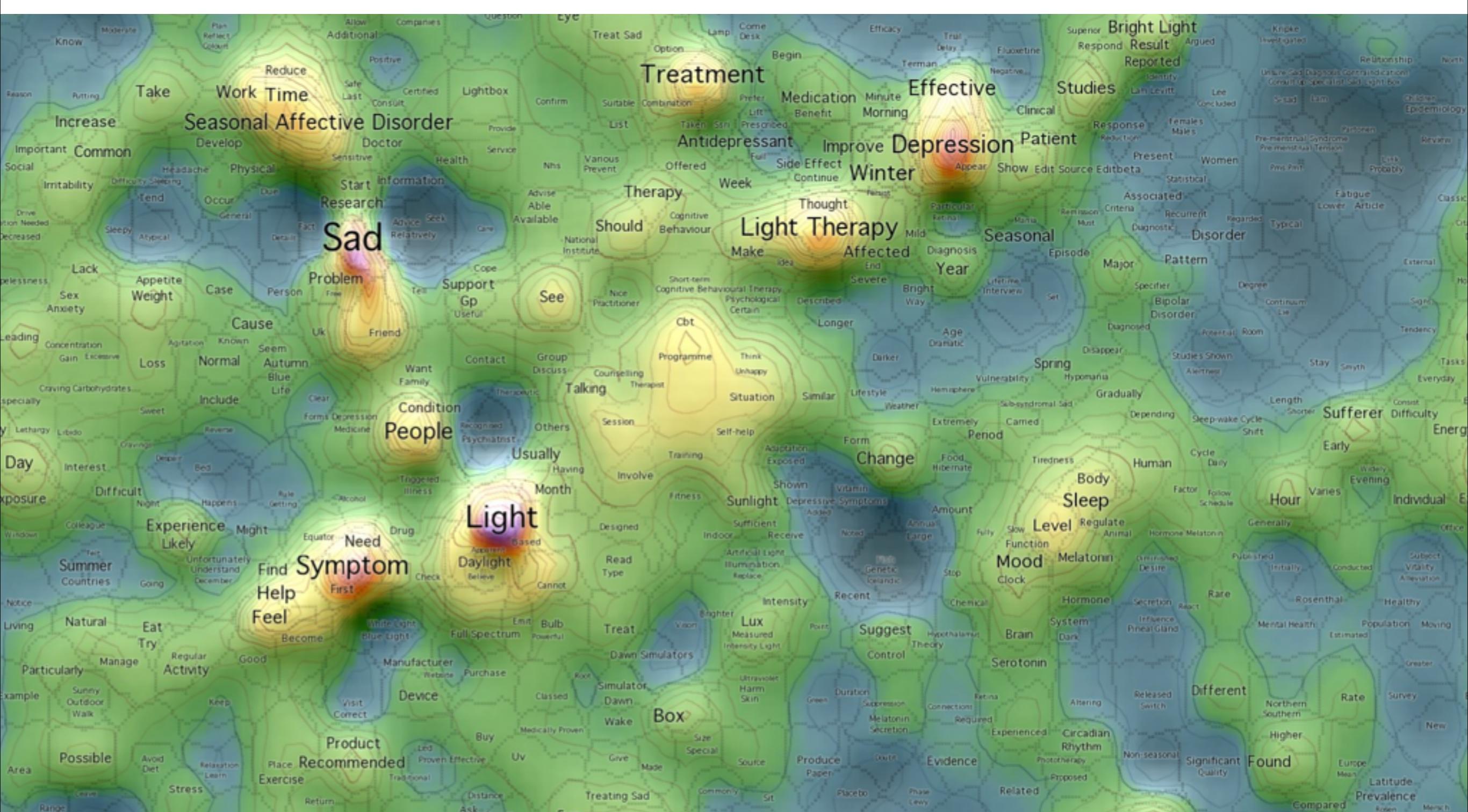
- be.Light Sensor (Matt Costello)

<http://www.matt-costello.com/portfolio/belight-/>





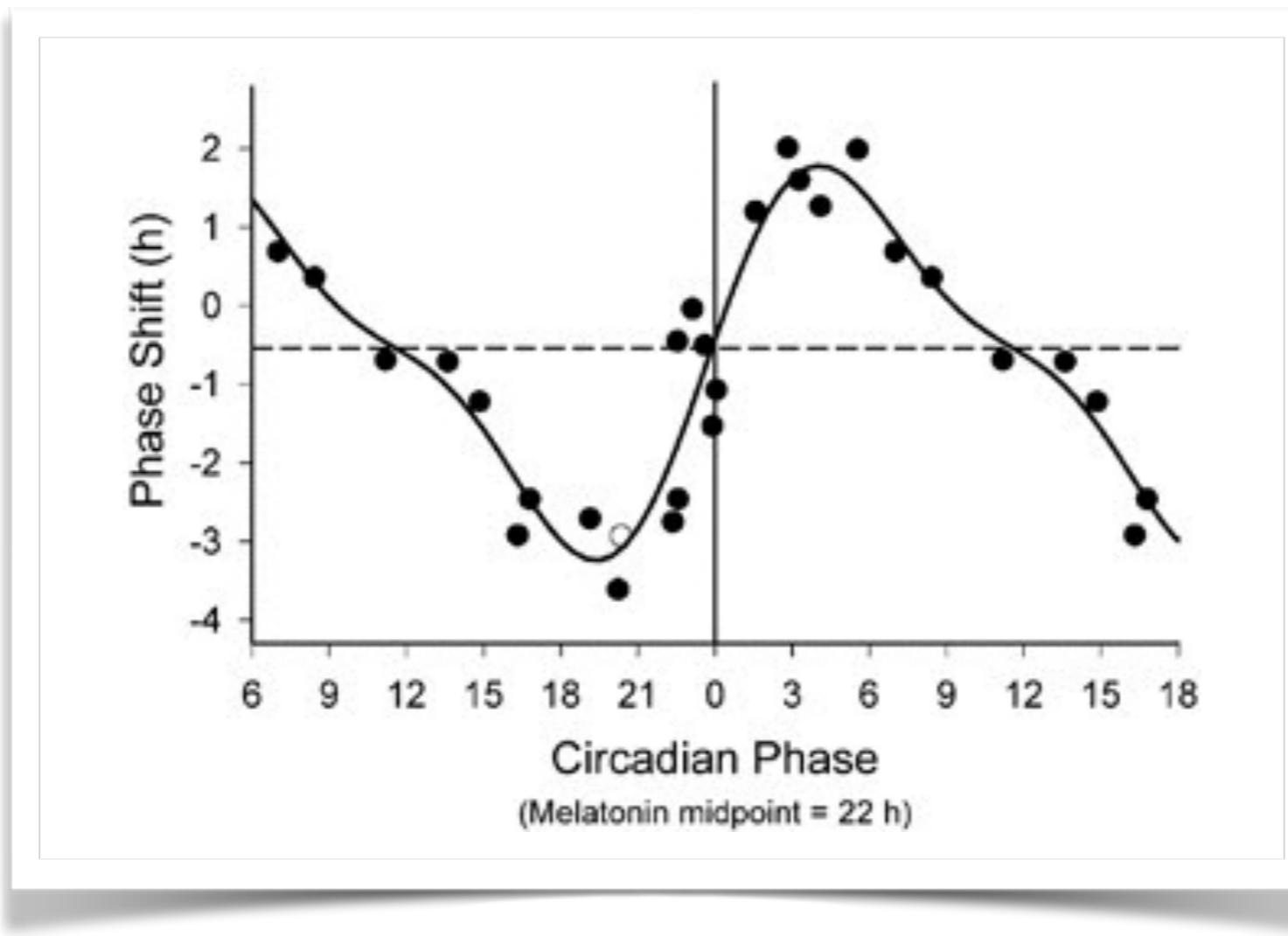
Seasonal Affective Disorder research SOM (~200 terms)



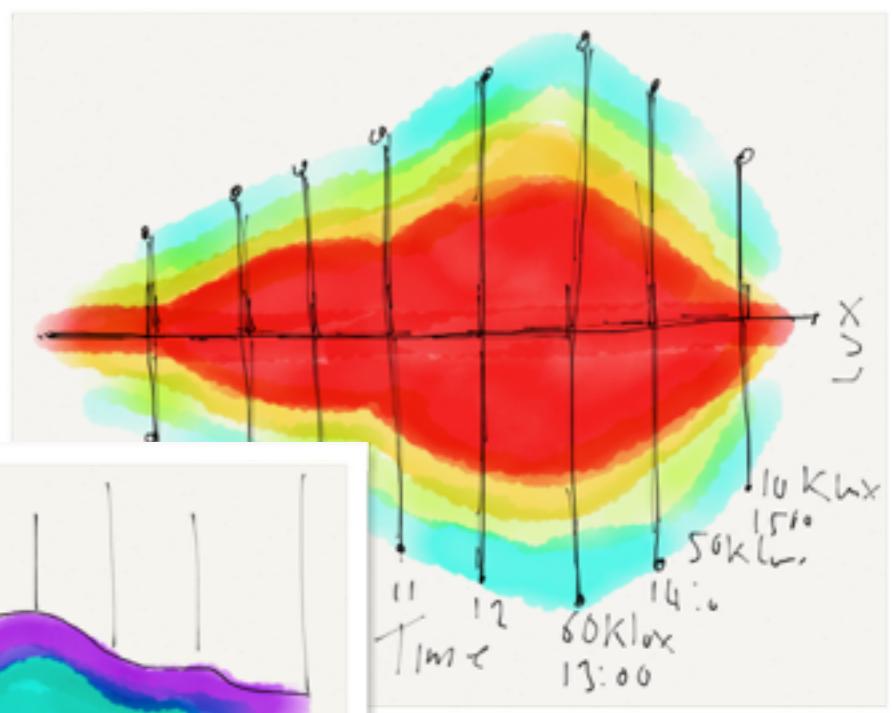
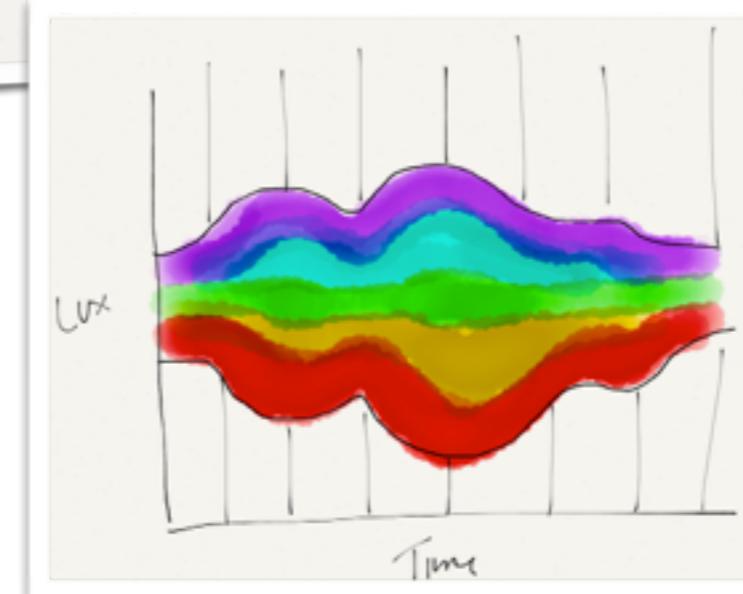
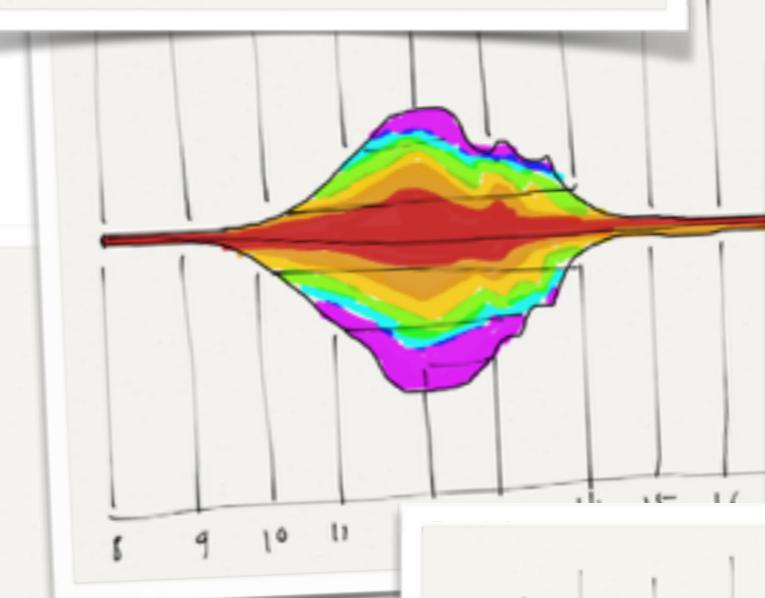
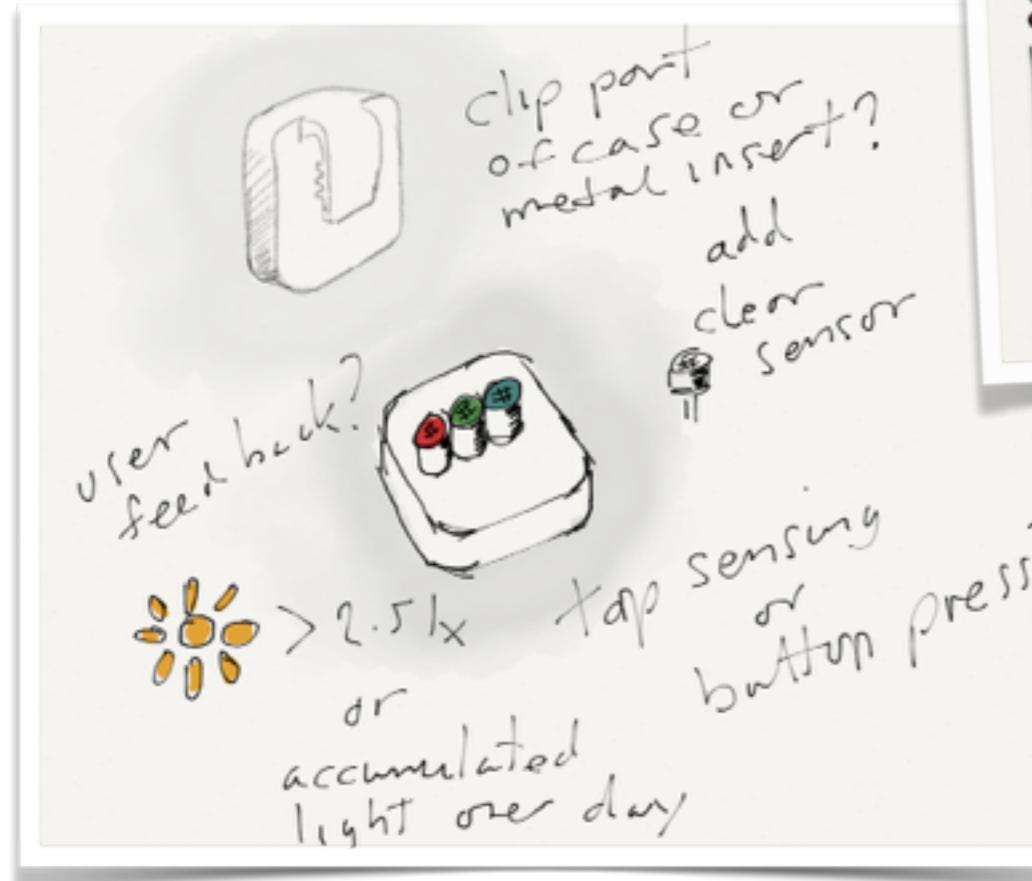
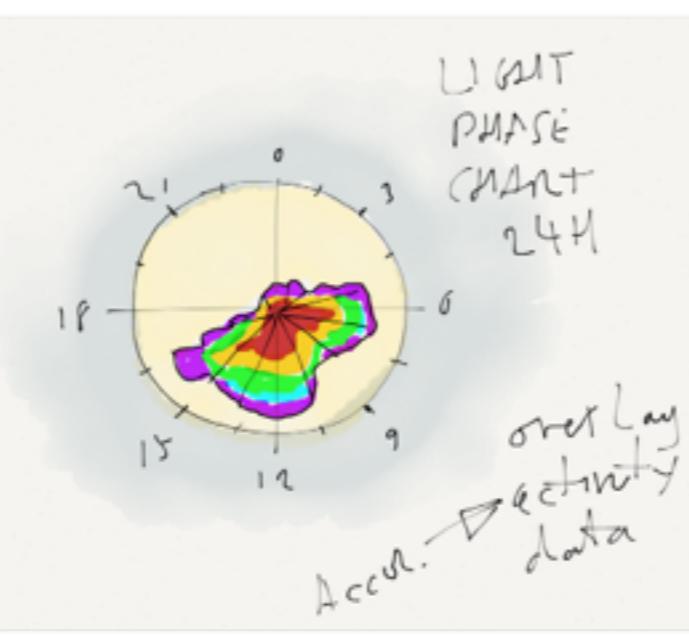
Seasonal Affective Disorder research SOM (~500 terms)

*“...circadian disruption negatively
affects human health...”*

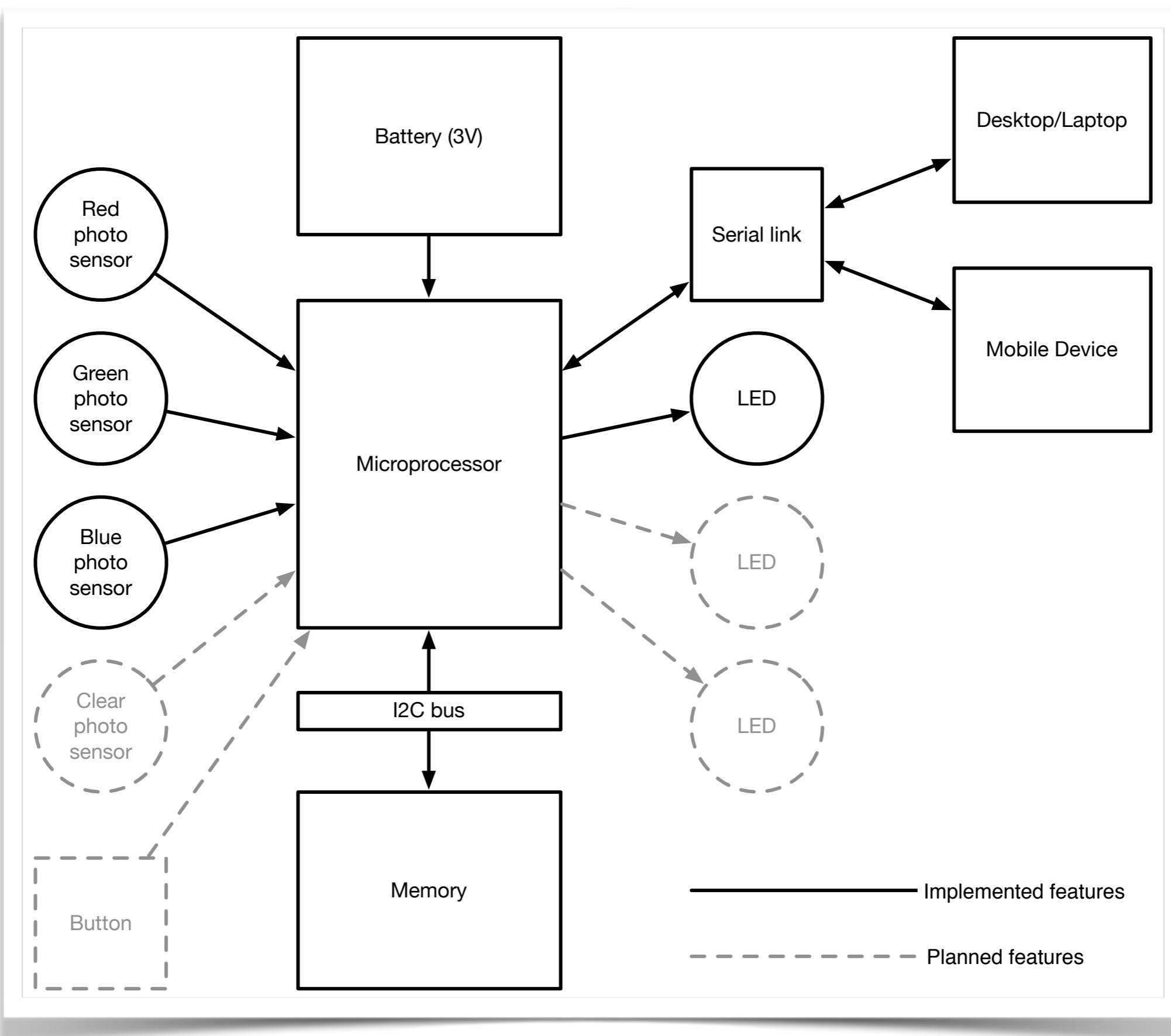
–Mark S Rea*, Andrew Bierman, Mariana G Figueiro and John D Bullough [1]



“Phase advances (positive values) and delays (negative values) are plotted against the timing of the centre of the light exposure relative to the melatonin midpoint on the pre-stimulus CR (defined to be 22 h), with the core body temperature minimum assumed to occur 2 h later at 0 h. Data points from circadian phases 6–18 are double plotted. The filled circles represent data from plasma melatonin, and the open circle represents data from salivary melatonin in subject 18K8 from whom blood samples were not acquired. The solid curve is a dual harmonic function fitted through all of the data points. The horizontal dashed line represents the anticipated 0.54 h average delay drift of the pacemaker between the pre- and post-stimulus phase assessments.”



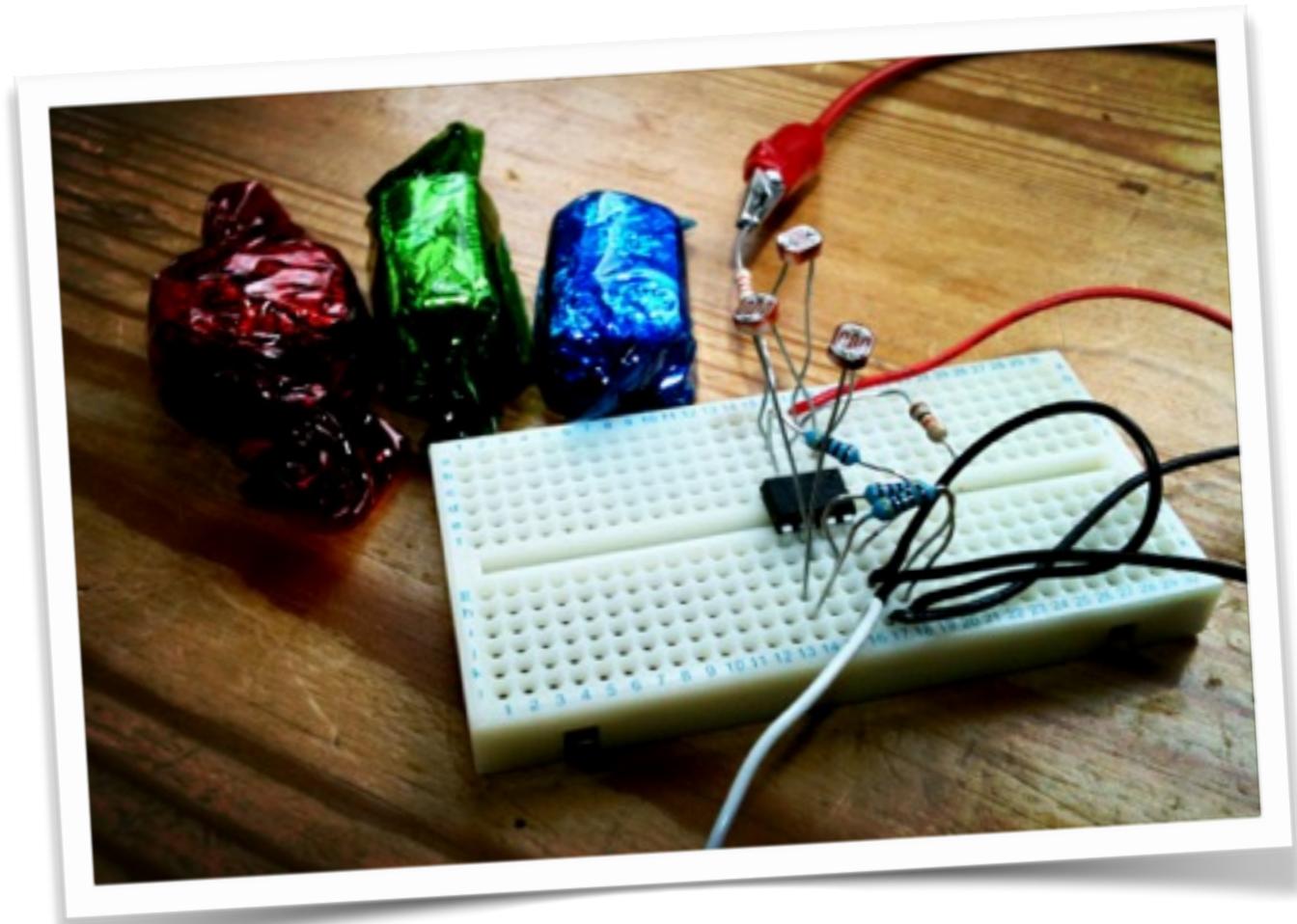
Design sketches



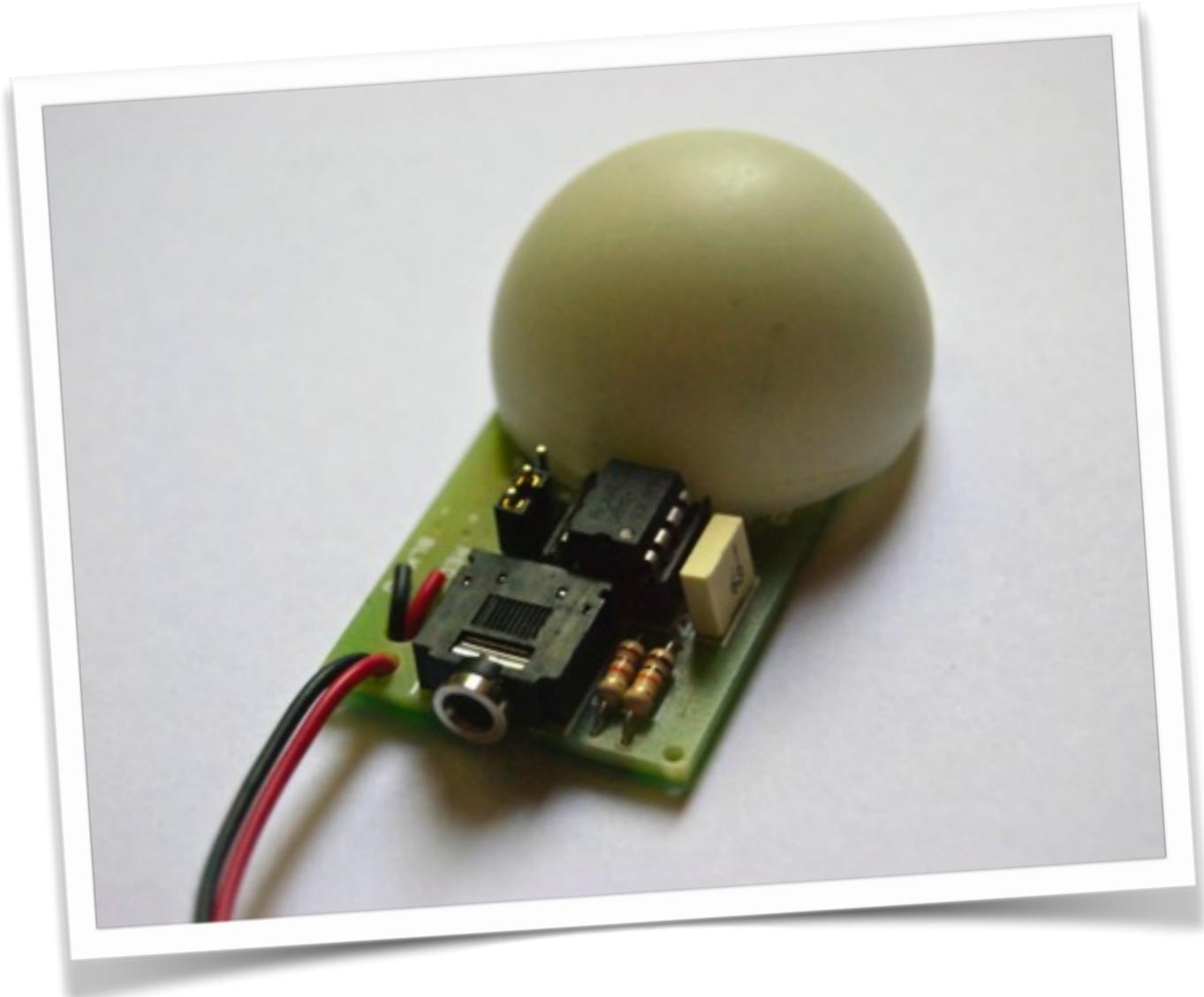
Light Log block diagram

Device design

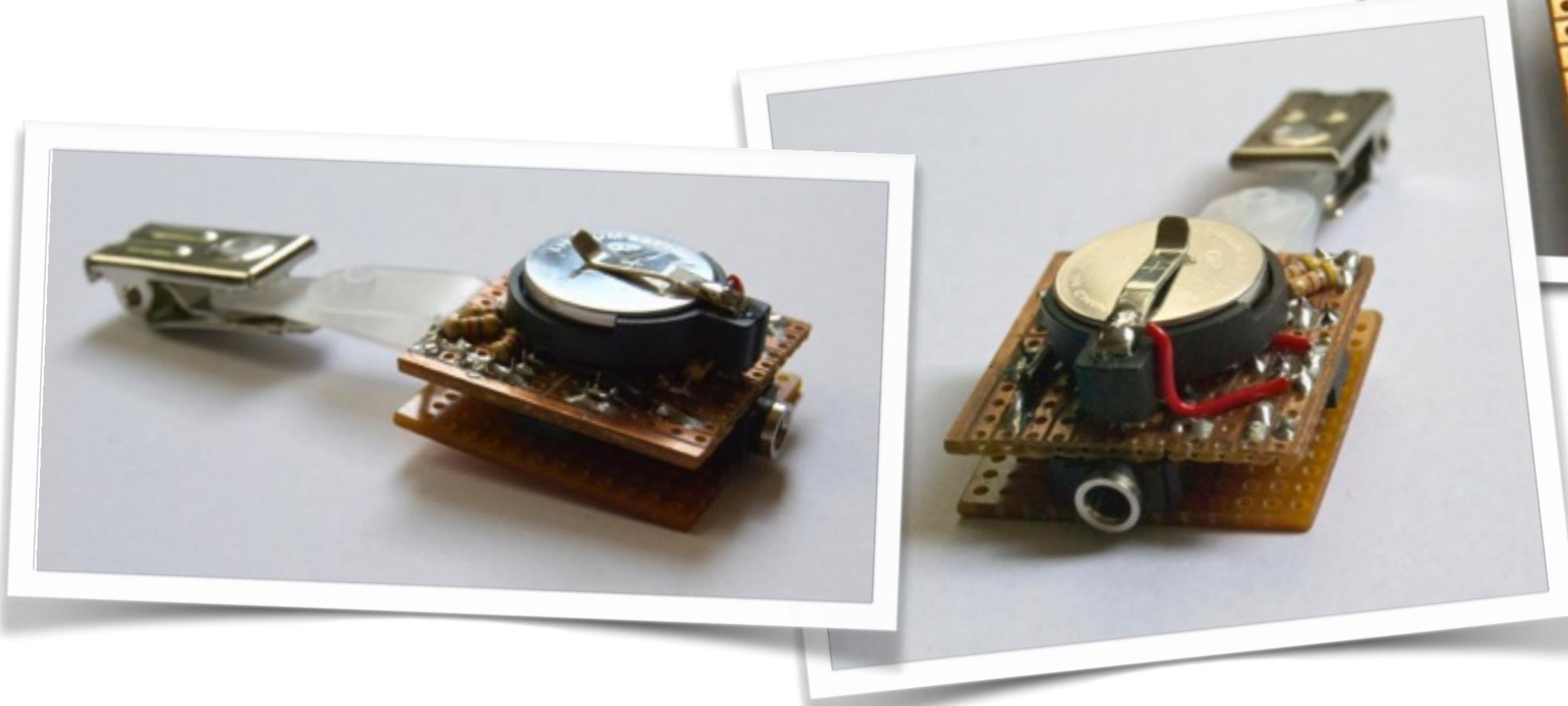
- 1st working prototype during 48hrs hack event
- Cellophane wrappers for colour light filters
- Only realtime logged to a connected laptop
- No data storage
- Breadboard
- Minimal micro code
- Logging raw numbers



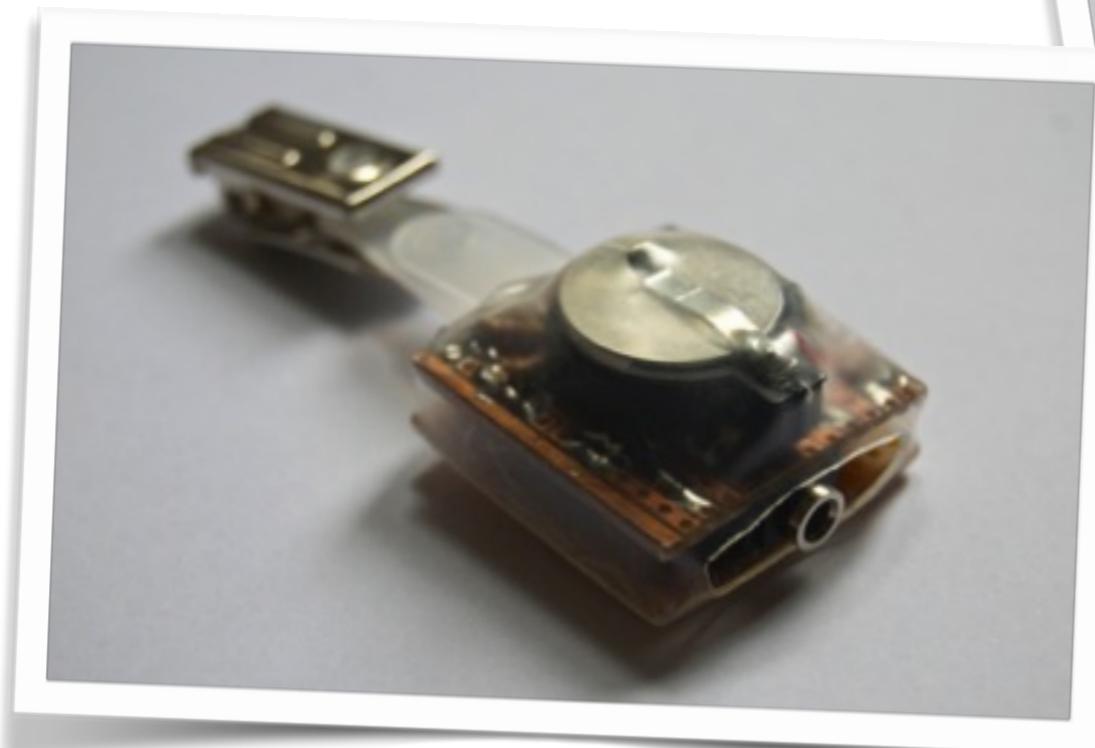
- 2nd prototype by the end of the 48hr hack event
- Still logged to a connected laptop
- Minimal 24hrs of memory storage
- Too bulky to wear
- Low sensitivity
- Simple graph output



- 3rd prototype (a month later)
- Syncs with desktop app (slow)
- ~1 week of continuous logging
- 1 month battery life
- LED output for user feedback

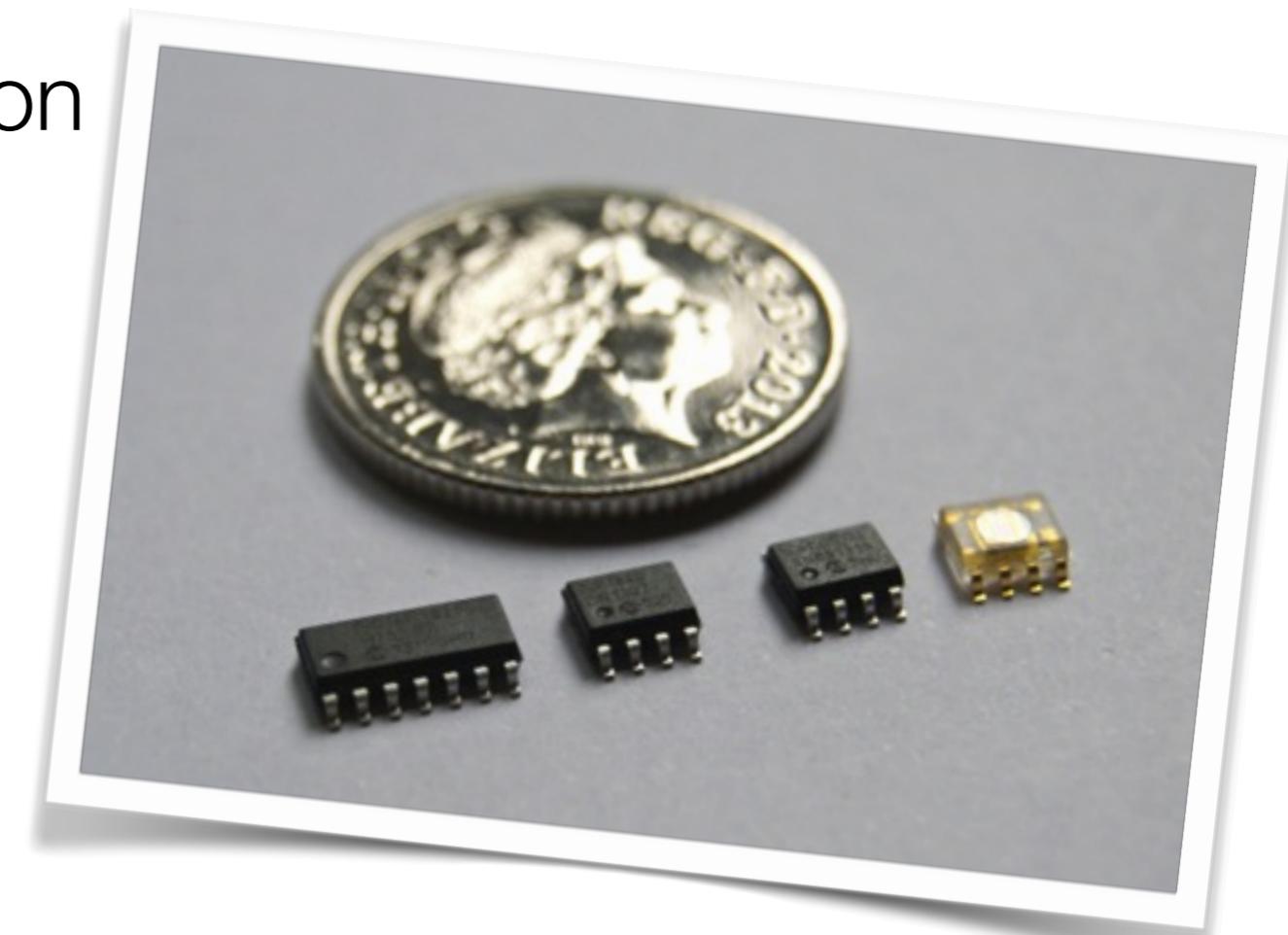


- 4th prototype
- Fast data sync (~15sec)
- ~4 months of logging
- ~4 months battery life
- Good colour filters
- Heat shrink weatherproofing



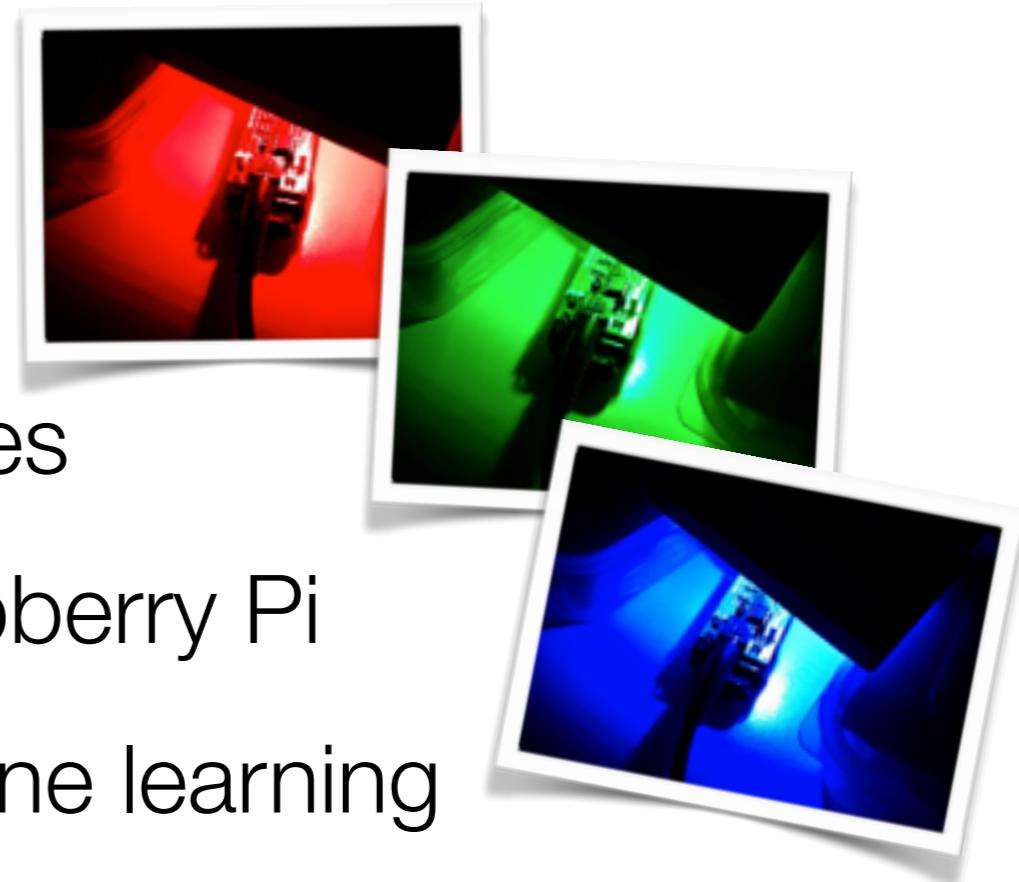
Next hardware steps

- Move to surface mount components (SMD)
- 3D printed & custom cases from Maker community
- Accelerometer for improved activity detection
- Improve occlusion detection
- Eagle CAD
 - PCB manufacture
 - Assembly of ~12 units
- Test deployment



Lux and colour data

- Maximise blue spectral response
 - Research suggests circadian phase is blue sensitive
- Calibration rig for reliable data
 - Trusted lux meters
 - Known temperature light sources
 - DIY spectrometer using Raspberry Pi
- Controlled data capture for machine learning
- Lots of data...



Light lux

Direct sunlight 32,000–130,000 lux

Full sunlight (not direct) 10,000–25,000 lux

S.A.D. treatment in the 2,500 to 10,000 lux range

Overcast day 1,000 lux

Office 320-500 lux

Domestic home lighting 50-150 lux

Very dark overcast day 100 lux

Laptop screen, white, min brightness 18 lux

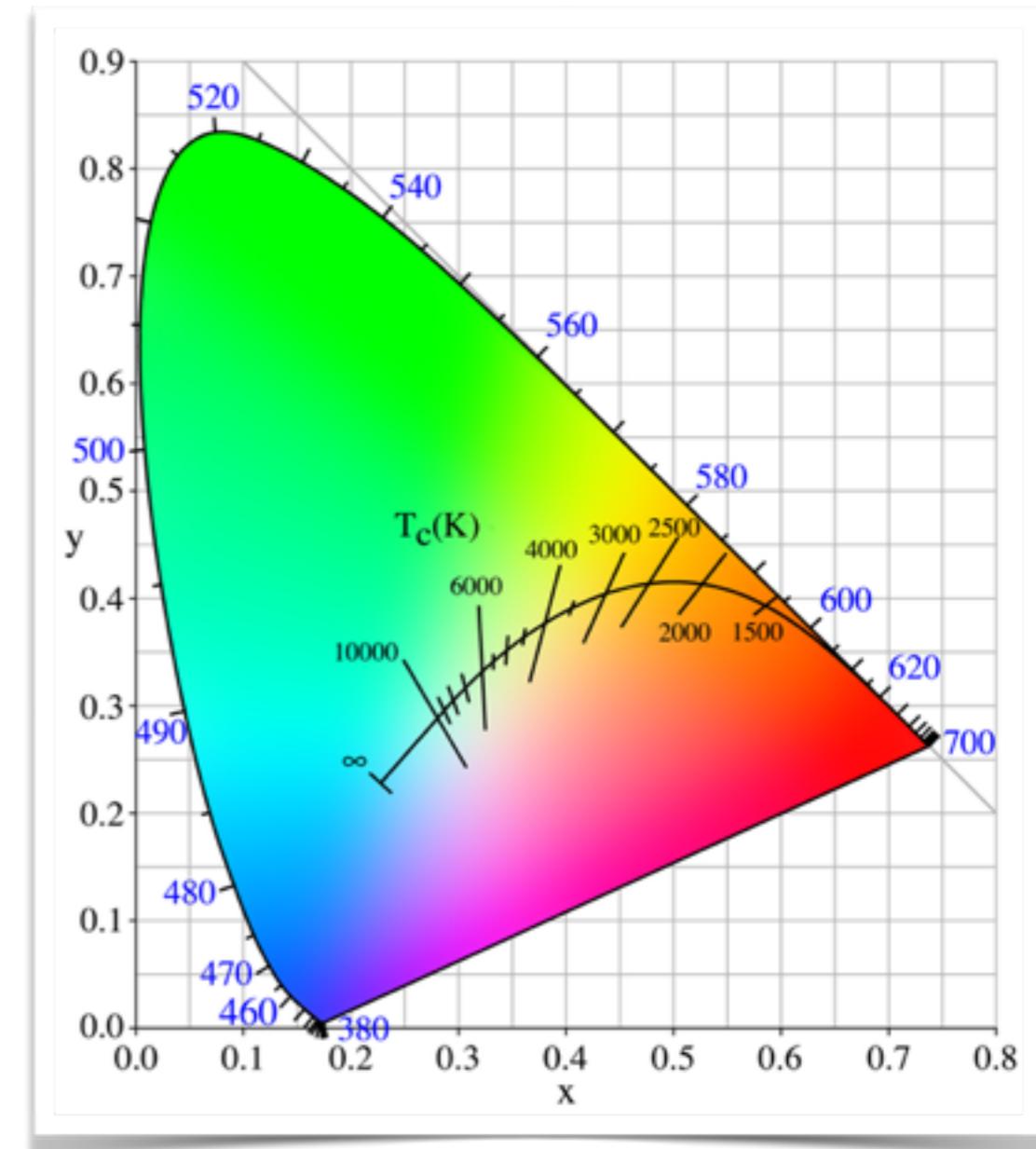
Twilight 10 lux

Full moon 0.3-1 lux

Moonless clear night sky 0.002 lux

Colour

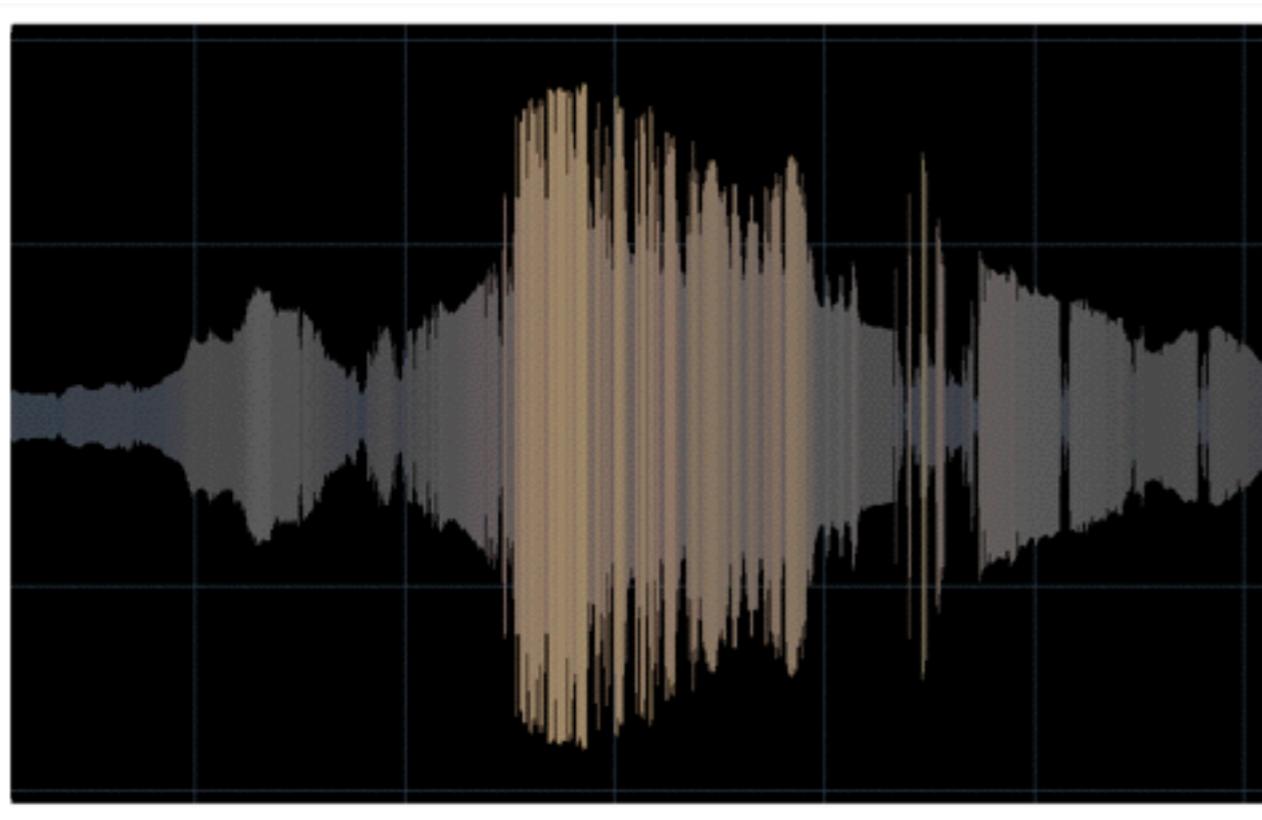
- Temperature (yellow-blue)
 - Match flame 1,700 K
 - Candle, sunset / sunrise 1,850 K
 - Incandescent lamp 2,700–3,300 K
 - Vertical daylight 5,500–6,000 K
 - Daylight overcast 6,500 K
 - Shade in daylight 7,500K
 - LCD / CRT 5,500–10,500 K
 - Blue sky 15,000–27,000 K
- Tint (magenta-green)
 - Gas-emission lighting
 - Fluorescent & neon lighting



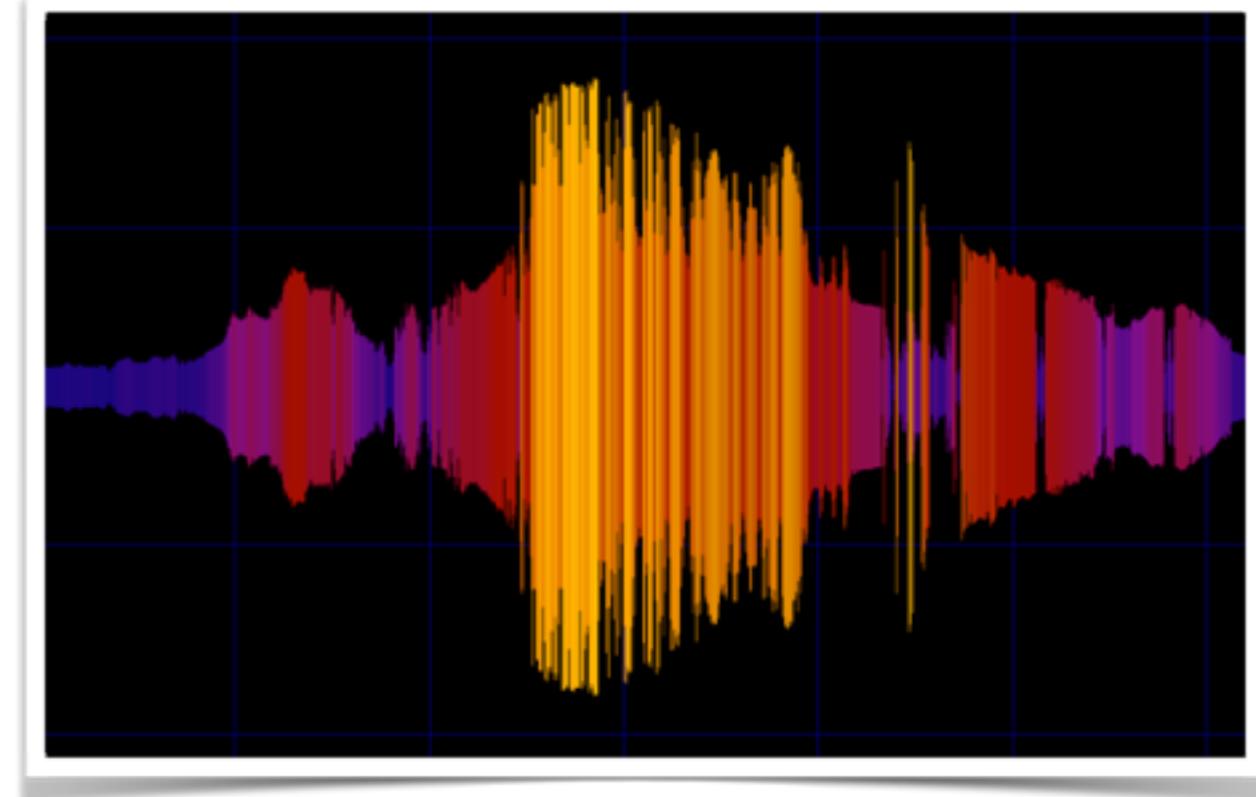
Signals in the data

- Activity data (moving vs. stationary)
- Colour change vs. lux variation
 - TV / video / computer game playing?
- Outdoor vs. indoor
 - Large change in magnitude is easy to detect
- Outdoor environment
 - Sunny blue sky vs. cloudy & overcast
- Sunrise & sunset
- Environment / location changes
 - Auto tagging via machine learning?
- Going to bed, getting up

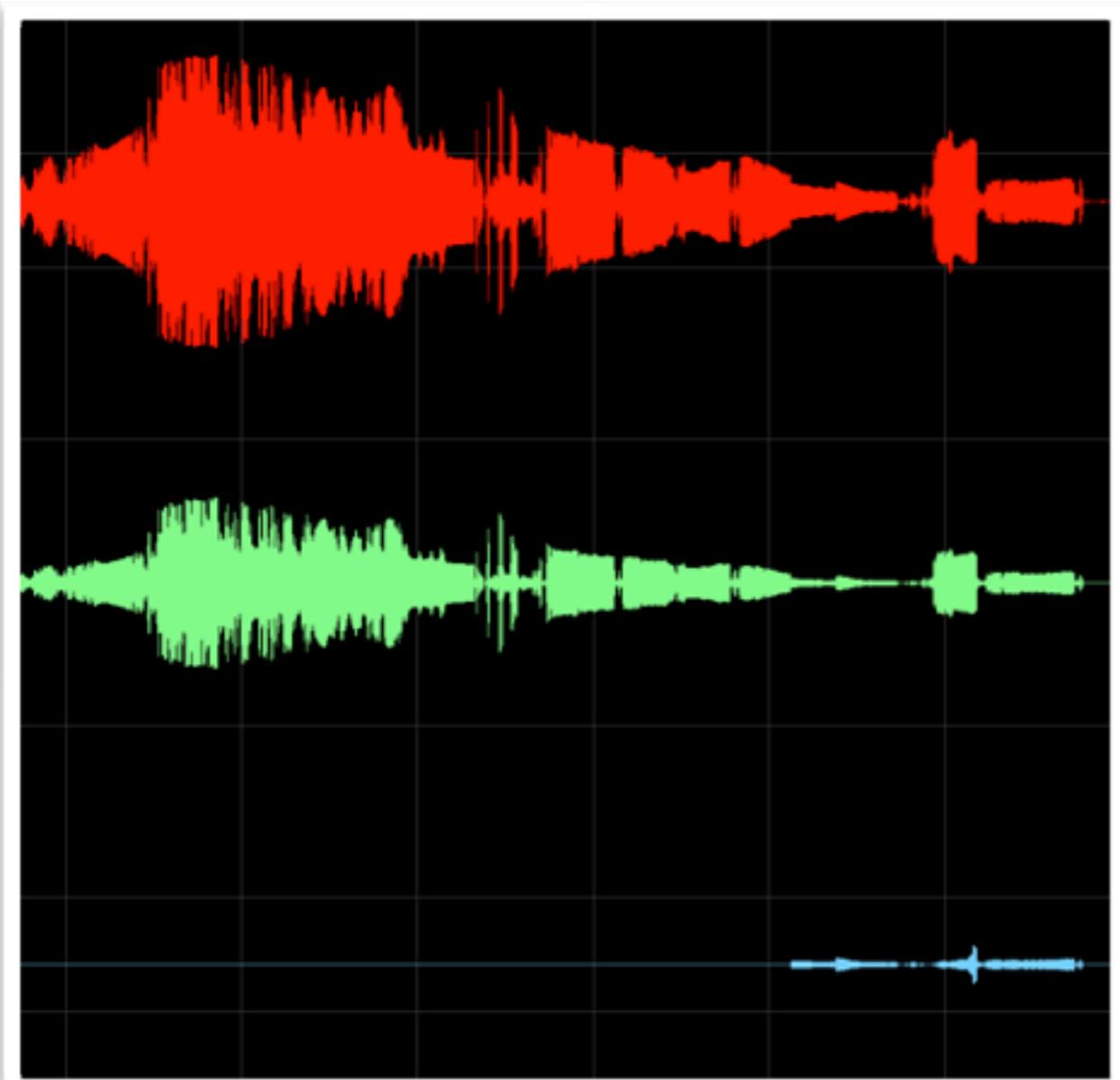
Data visualisations



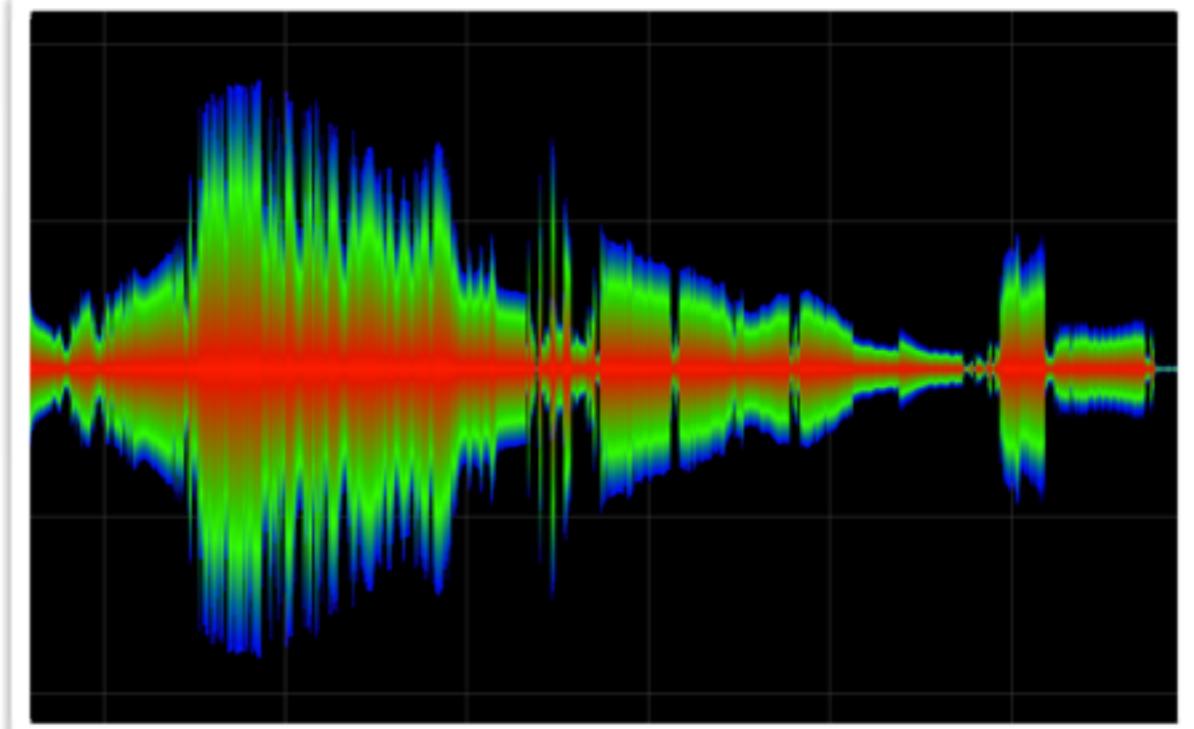
True colour
‘Gruel & Gravy’



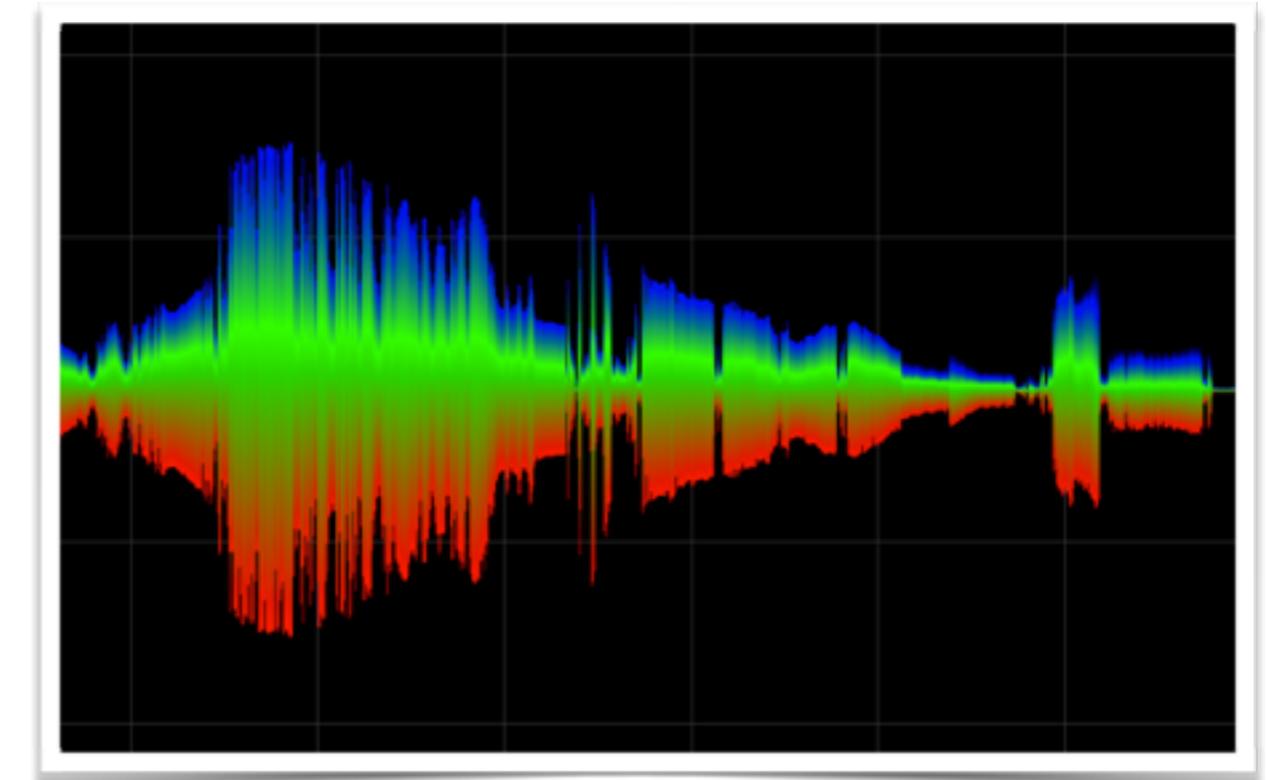
False colour



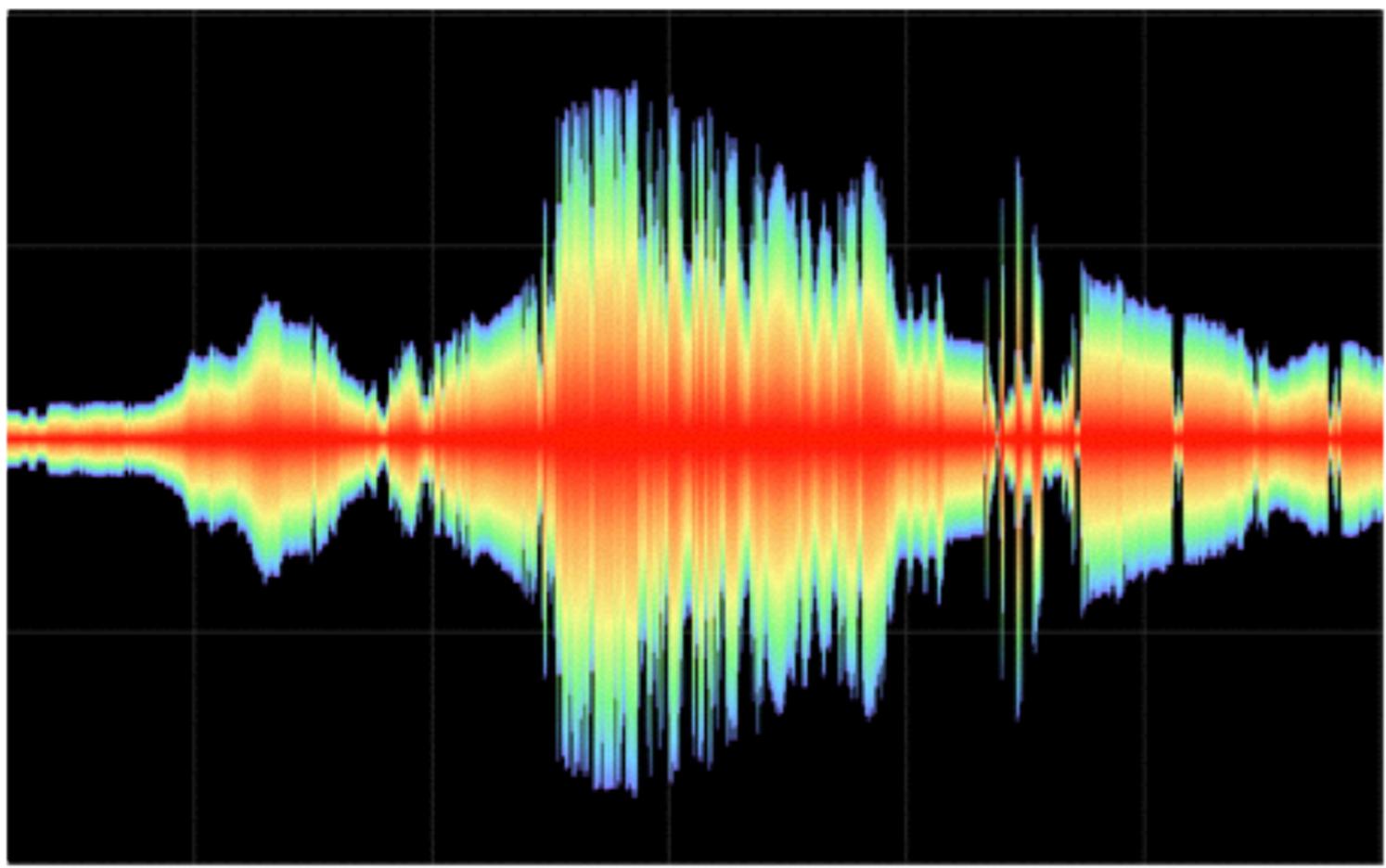
RGB channels



RGB mirror stacked

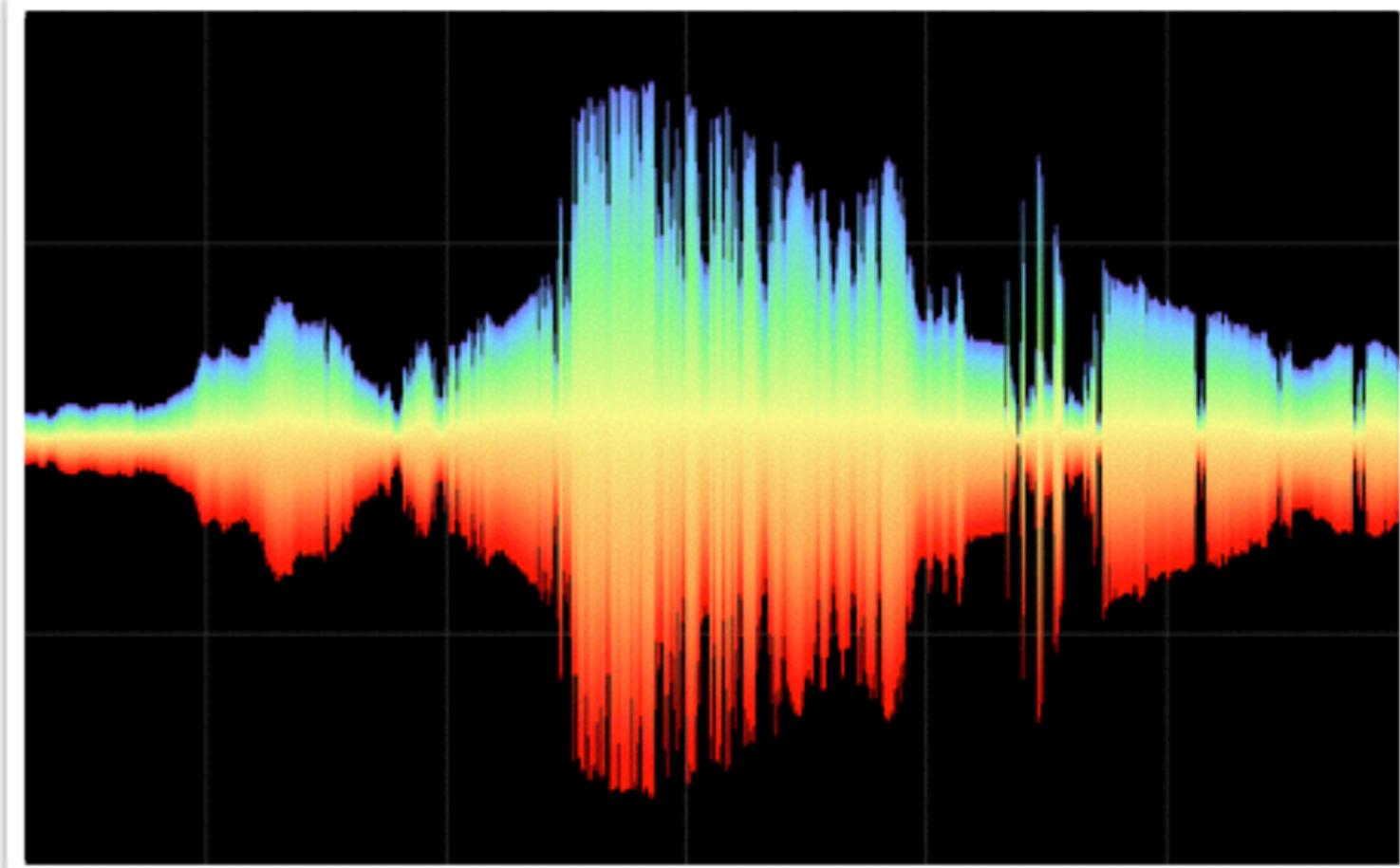


RGB stacked



Colour
spectrum
stacked
mirror

Colour
spectrum
stacked



Longer term goals

- Ongoing community building
- Maintenance and support
 - of devices
 - of apps
- Ride Moore's Law
 - Bluetooth LE sync support
 - Smaller
 - Improve battery life
 - Improve display and user feedback (sound, vibration?)

Some things to keep in mind

- Existing data on how light effects humans is limited
 - Often small numbers of participants
 - Often over short durations
- Hawthorne effect [3]
- Placebo effect
- Potentially strong variations from person to person
- Don't over promise results, focus on engaging user in increasing their positive behaviours

Acknowledgements

New Media Scotland

Creative Scotland

Centre for Design Informatics

Scottish Government

Project Ginsberg

NHS 24

References

1. Mark S Rea*, Andrew Bierman, Mariana G Figueiro and John D Bullough. A new approach to understanding the impact of circadian disruption on human health. *Journal of Circadian Rhythms*, 2008.
2. Sat Bir S Khalsa, Megan E Jewett, Christian Cajochen, and Charles A Czeisler. A phase response curve to single bright light pulses in human subjects. *The Journal of Physiology*, 2003

3. Rob McCarney, James Warner, Steve Iliffe, Robbert van Haselen, Mark Griffin, and Peter Fisher. **The Hawthorne Effect: a randomised, controlled trial.** BMC Med Res Methodol. 2007