

## 8. *Harmful electromagnetic radiation*

- ionising (from nuclides, mainly from radon – not just gamma, beta and alpha too)
- solar (UV, but also macular degeneration of retina due to blue component after a long-year exposure) – how much sun is enough for D-vitamine production?
- man-made: **Light at Night**  
*(in extenso: see the slides for the 5th grade)*

# Light themes

- *discussion: do you have enough darkness for sleep? How do you protect yourselves from light if it disturbs you?*
- *How long do you sleep in various situations (response on leaflets)*
- Why the sleep is so important, even for studying...
- light measurement below the table, by the wall, by the window, outside, to the eyes
- yellow glasses influence

# Light as a pollutant

- Light pollution – no heavy issue?
- Outdoors: **any light added artificially**  
(at night) alters its natural state
- Indoors? It has no natural state, being artificial itself. As long as we light it on purpose:
  - light which could harm our health...

# Darkness: a basic attribute of night

- Darkness, what's that?
- Less light than short ago
  - or in adjacent area.
- Common in daytime too...
- There is light outdoors in nature at night,
  - but less of it below a roof or in a forest.
- No light: just totally enclosed spaces.

# Day and night alteration: the basic rhythm of our world

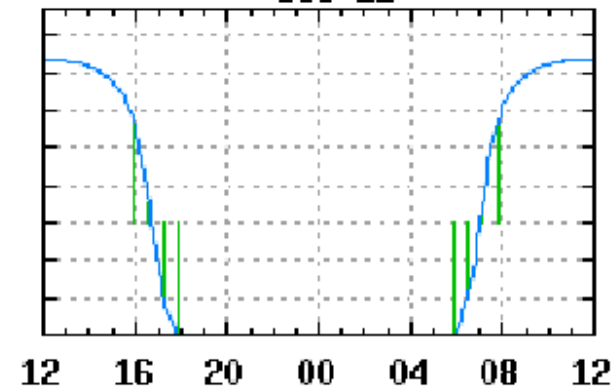
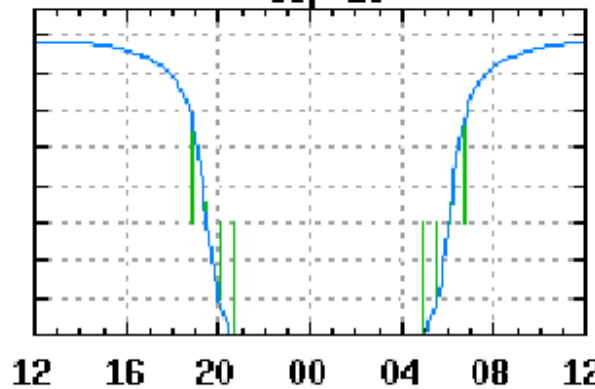
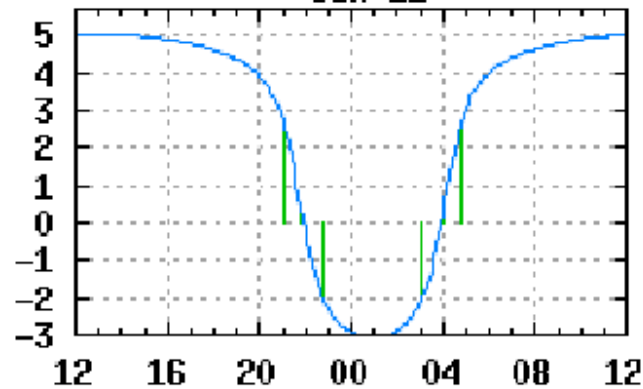
- sunny day, winter to summer, flat terrain:  
30 thousand to 100 thousand lux
- 1/1000 lx at night
- overcast: 3x to 30x less
- day/night ratio: 3 millions to 1000 millions
- full moon night – 1/10 lx  
(the ratio day/night diminishes 100x)

# log (horizontal illuminance / 1 lx) clear sky, with/out Moon

- Jun 22

- Sep 23

- Dec 22



*letní slunovrat*

(6,3 h, astron. nenastává)

- 2006-09-02

*rovnodennost*

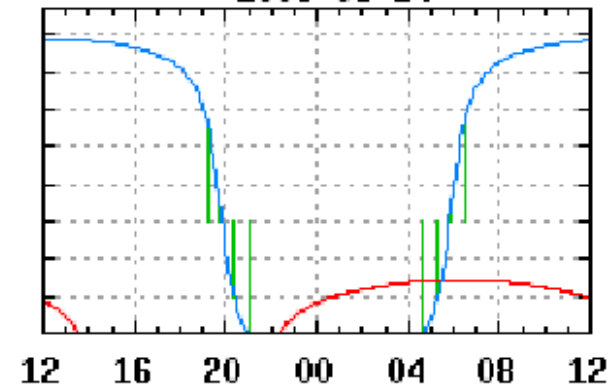
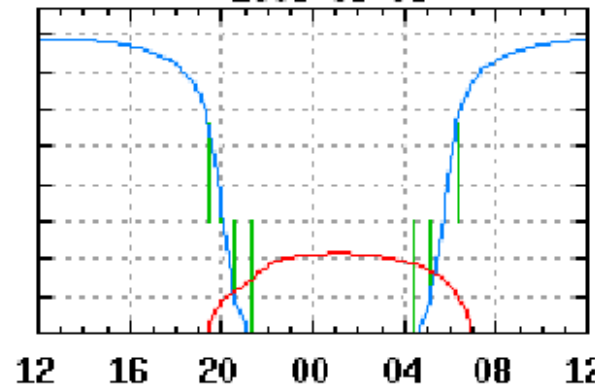
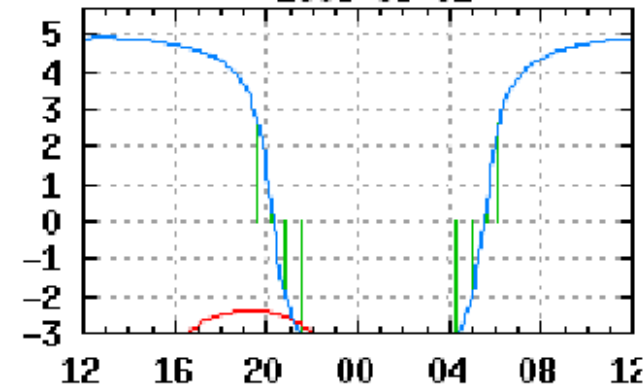
(10,7 h, 8,2 h)

- 2006-09-08

*zimní slunovrat*

(14,5 h, 11,9 h)

- 2006-09-14



*půl dne po první čtvrti*  
(max. 0.004 lx, ve dne...)

*úplněk*  
(téměř 0,2 lx)

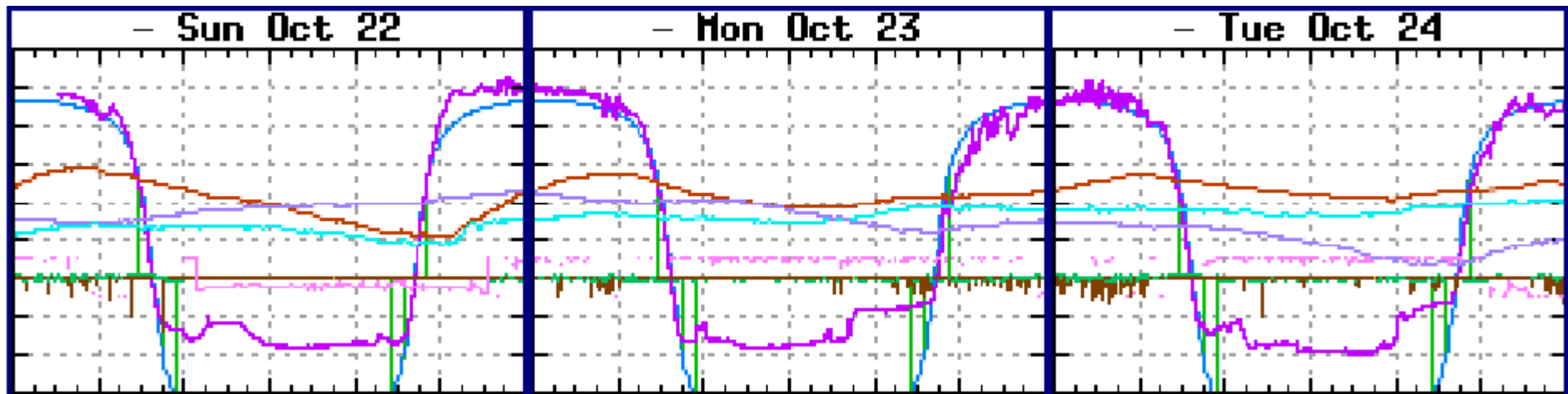
*0,5 d před poslední čtvrtí*  
(až 0,03 lx)

# And indoors?

- Orders of magnitude less light than outdoors – *originally*
- Now, tens to hundreds lux at night
- Often more than during daylight...
- *24/7*

# Brno, Kuhberg

- Clear sky: 1 to 2 centilux  
instead of 1 millilux
- Overcast: decilux levels

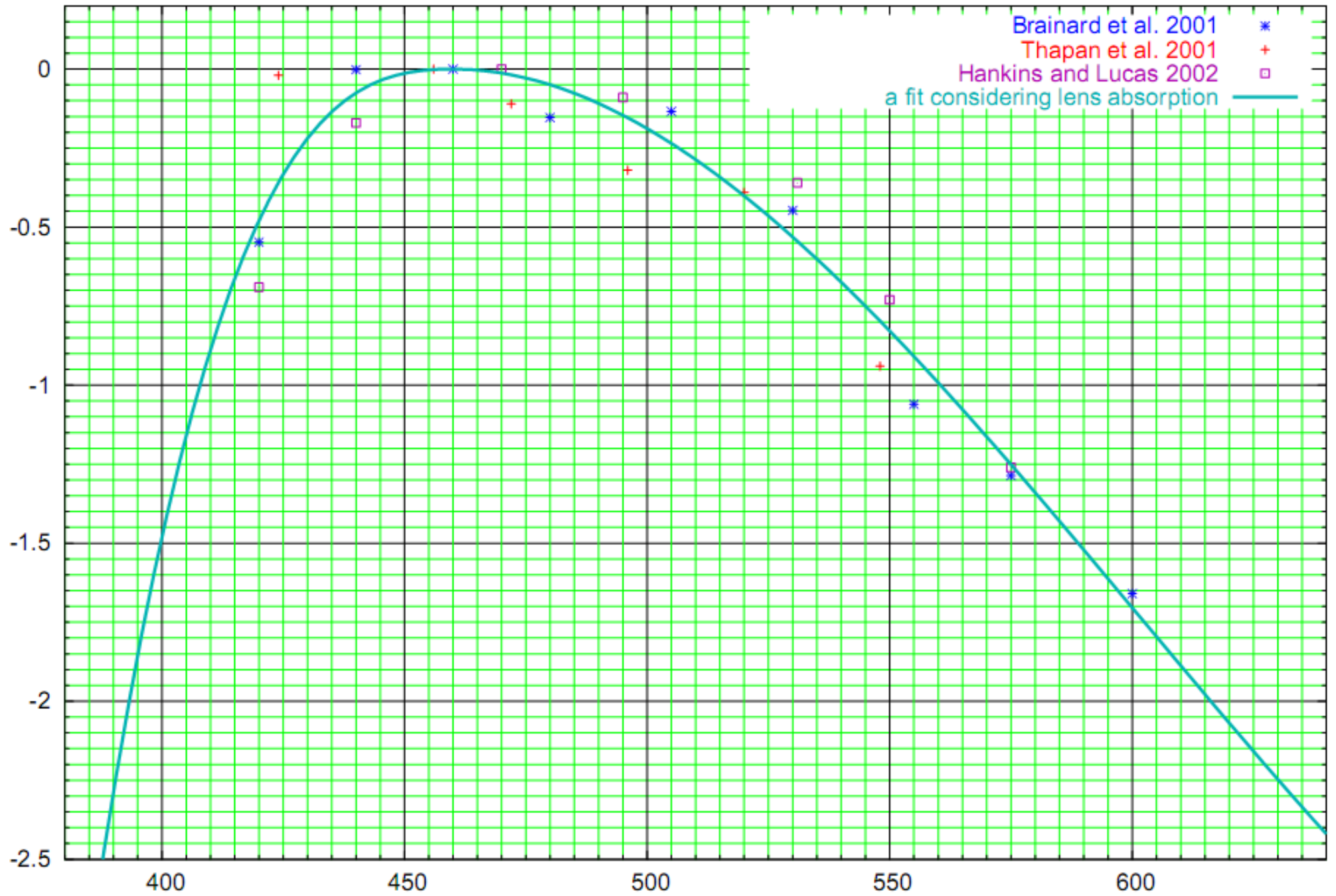




# Circadian rhythm, melatonin

- natural night and melatonin production is 11 h in average (more in winter, less in summer)
- our electric culture shortened it to the sleeptime
- breast and prostate cancer, obesity, diabetes

Action spectrum of melanonin suppression by light"



Stevens, R.G. Electric power use and breast cancer: a hypothesis. *Am. J. Epidemiol.* **125**, 556 (1987).

[Stevens, R.G.](#) Light-at-night, circadian disruption and breast cancer: assessment of existing evidence. *International Journal of Epidemiology* **38**, 963-970 (2009):

**Background** Breast cancer incidence is increasing globally for largely unknown reasons. The possibility that a portion of the breast cancer burden might be explained by the introduction and increasing use of electricity to light the night was suggested >20 years ago.

**Methods** The theory is based on nocturnal light-induced disruption of circadian rhythms, notably reduction of melatonin synthesis. It has formed the basis for a series of predictions including that non-day shift work would increase risk, blind women would be at lower risk, long sleep duration would lower risk and community nighttime light level would co-distribute with breast cancer incidence on the population level.

**Results** Accumulation of epidemiological evidence has accelerated in recent years, reflected in an International Agency for Research on Cancer (IARC) classification of shift work as a probable human carcinogen (2A). There is also a strong rodent model in support of the light-at-night (LAN) idea.

## Conclusion

If a consensus eventually emerges that LAN does increase risk, then the mechanisms for the effect are important to elucidate for intervention and mitigation. The basic understanding of phototransduction for the circadian system, and of the molecular genetics of circadian rhythm generation are both advancing rapidly, and will provide for the development of lighting technologies at home and at work that minimize circadian disruption, while maintaining visual efficiency and aesthetics. In the interim, there are strategies now available to reduce the potential for circadian disruption, which include

- extending the daily dark period,
- appreciate nocturnal awakening in the dark,
- using dim red light for nighttime necessities,
- and unless recommended by a physician, not taking melatonin tablets.

Kloog, I., Haim, A., Stevens, R.G., Barchana, M. & Portnov, B.A.

**Light at Night Co-distributes with Incident Breast but not Lung Cancer in the Female Population of Israel.**

*Chronobiology International* **25**, 65-81 (2008).

Kloog, I., Haim, A., Stevens, R.G. & Portnov, B.A.

**Global Co-Distribution of Light at Night (LAN) and Cancers of Prostate, Colon, and Lung in Men.**

*Chronobiology International* **26**, 108-125 (2009).

Kloog, I., Portnov, B.A., Rennert, H.S. & Haim, A.

**Does the Modern Urbanized Sleeping Habitat Pose a Breast Cancer Risk?**

*Chronobiol Int* **28**, 76-80 (2011)

# Basic rules for outdoor lighting (like in Slovenia and most of Italy)

No emissions horizontally and upwards

Using just that much light, what's necessary  
for the task, no more than  $1 \text{ cd/m}^2$  or  $10 \text{ lx}$

Ads max. 10 x more luminance than  
surroundings (3 x is enough)



**Yellow**, faint light (lux to dekalux)  
for night work

and just centilux/millilux levels

for moving during sleeptime

should become a norm



# Technical measures

- replace old lights by new, fainter, better aimed ones
- dimming,
- filtering,
- shading (*help yourself to sleep well – i.e., employ protective aids*)

# Can you spoil your eyes by *faint* light?

- Did you ever hear „*light up! don't damage your vision*“?
- What physiology mechanism could do that?
- All creatures, do they have their vision spoiled? Do just the happy people supplied with electricity see really well when old?
- Faint light does not contract eye pupils, so the vision is to be properly in focus. People over 50 have to use various glasses, cheap ones are OK, but more than 1 or 2 are needed
- Very faint light implies more effort for the brain only, so we are tired and go to sleep sooner – OK!

# Light: Good Servant, but a Bad Lord!

<http://amper.ped.muni.cz/light/declaration/>

## 9. *Noise toxicity*

- <http://www.cochlea.org/en/noise>
- <http://www.cochlea.eu/en/pathology/presbycusis>
- (on hair cells:  
<http://www.cochlea.eu/en/hair-cells>)
- *(on noise in detail, see the slides 5. grade)*

# Noise then and now

- how to get back to harmless levels?

# Noise - various meanings

- strong sound
- sound with no recognizable tones, no melody
- any sound we don't want to hear
- antipode of silence
- Noise – the same root as Nausea

# Noise / Sound

- Sound pollution?
- (sound: OK, good, healthy, reasonable...)
- Therefore: Noise pollution
- or, better, Acoustic pollution

# More noise targeting us

- Natural phenomena
- Anthropogenic sources, preindustrial
- Its new sources in the 20-th century
- ... and in the 21-st one...



# Weber-Fechner law

- what we perceive, is the ratio of inputs
- - i. e., the increment of the
  - logarithm

# Quantification

- $L_p = 10 \text{ dB} \cdot \log(p^2/p_0^2)$

$$p_0 = 2 \cdot 10^{-5} \text{ Pa}$$

- $L_I = 10 \text{ dB} \cdot \log(I/I_0)$

$$I_0 = 10^{-12} \text{ W/m}^2$$

- That's for 1000 Hz...

# What's 1000 Hz?

- and what spectral composition the real sounds have,
- like speech?

# Some loudness levels

- pneumatic chipper at 1 metre 115
- hand-held circular saw at 1 metre 115
- power lawn mower at 1 metre 92
- diesel truck 50 km/h at 20 metres 85
- passenger car 60 km/h at 20 metres 65
- conversation at 1 metre 55
- quiet room 40
- ... and what about less?

# Ten times, two times, three times..

- 
- How many decibels it amounts to?

# 5 dB, that is some ratio of energy fluxes

- and further 5 dB the same ratio
- together, it is 10 dB, that is 10x more
- so, 5 dB is a square root of that, or roughly

3:1 ratio:

- 5 dB more means (just a bit more than) 3x more

# Health effects

- [en.wikipedia.org/wiki/Noise\\_health\\_effects](https://en.wikipedia.org/wiki/Noise_health_effects)
- hearing impairment – over the aging-dependent one  
(high frequencies most affected, loss of speech recognition)
- tinnitus
- hypertension
- cardiovascular
- discomfort, anger
- sleep disturbance

# Sleep well?

- Darkness  
and silence  
are *a must*



# Technical measures against noise

- barriers to its propagation
- emission reduction
- protect yourself!