



LED lamps and possible flicker

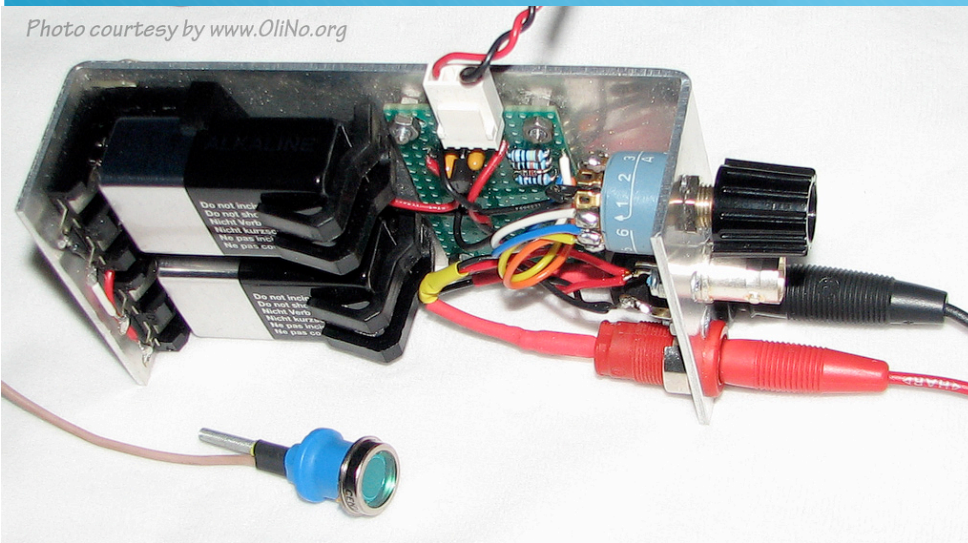
Explanations and measurement results

LED lamps flicker - init

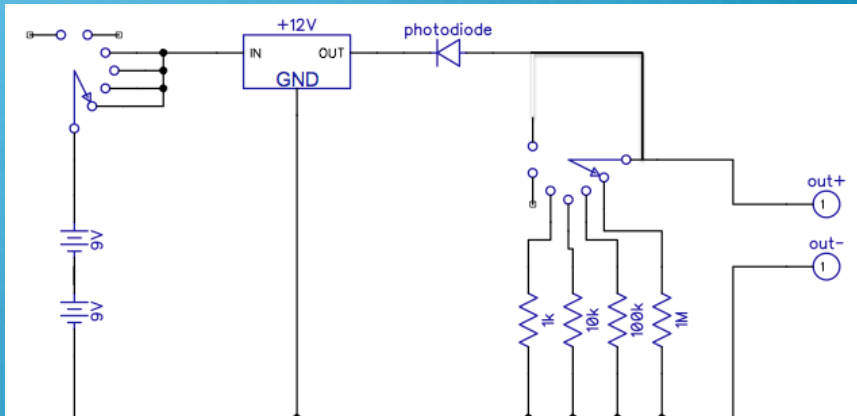
- ◊ Article NP in 2009, headaches and led lighting
- ◊ Fast (100 Hz) variations of light intensity?
- ◊ → Due to power supply/driver → varying output
- ◊ What to measure – no norms?

Measurement setup

Photo courtesy by www.OliNo.org

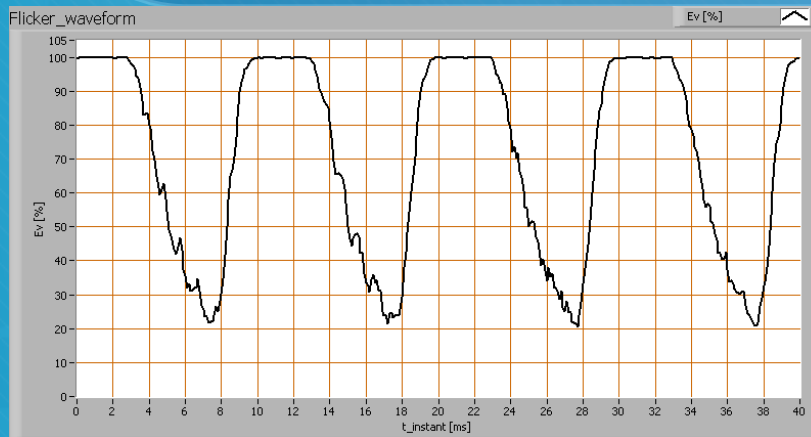


- Photo diode
- Amplifier
- Fast, up to 5000 Hz

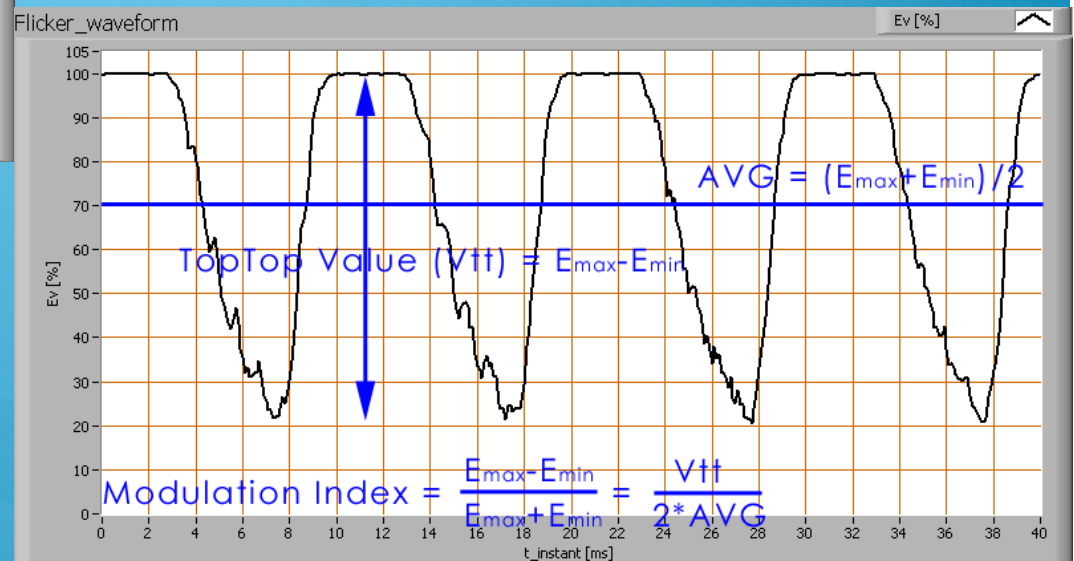


Measurement parameter

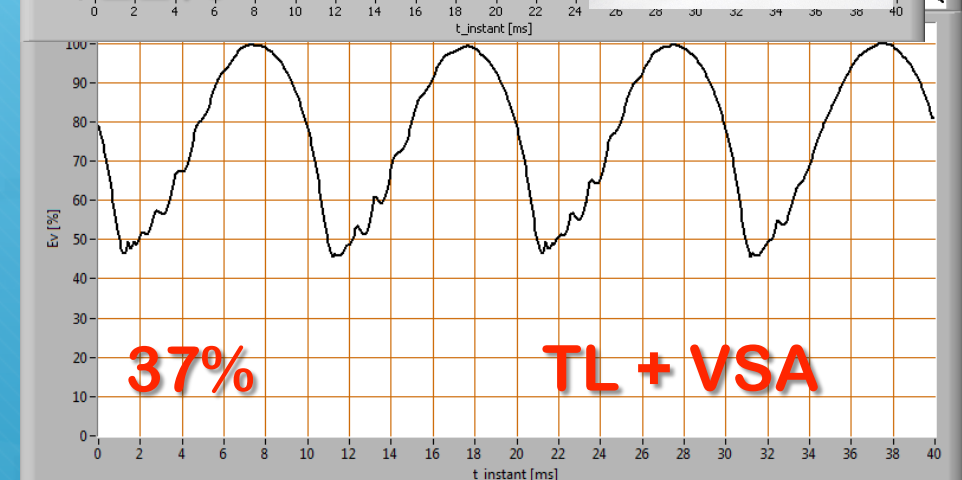
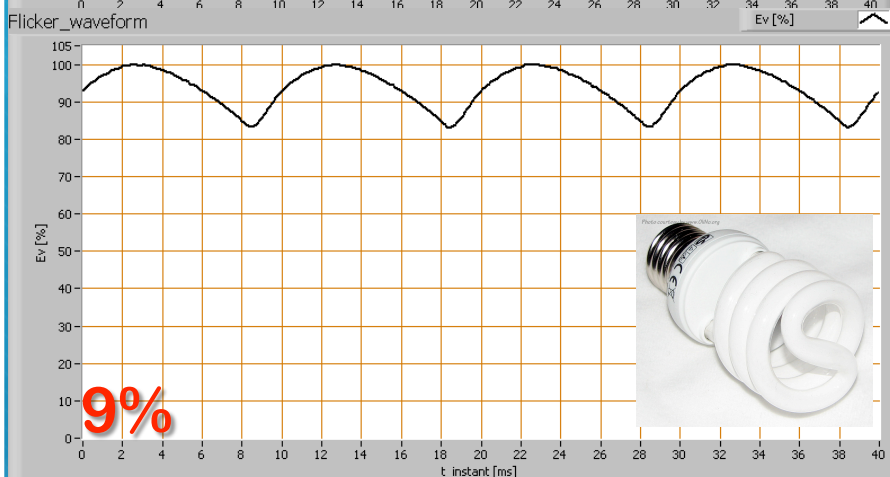
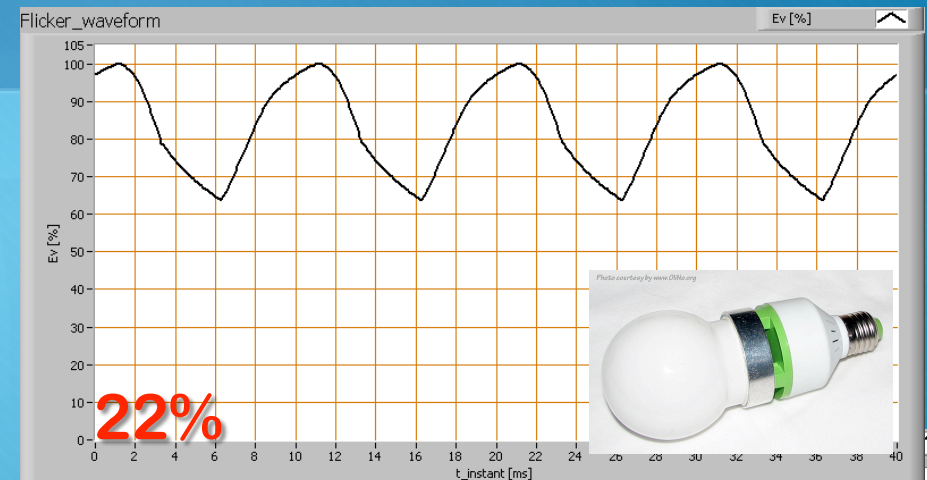
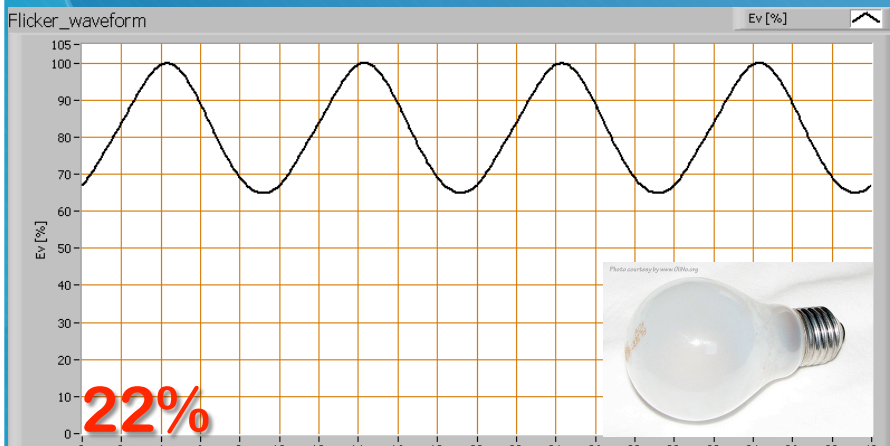
- Fast variations in illuminance
- Look for parameter



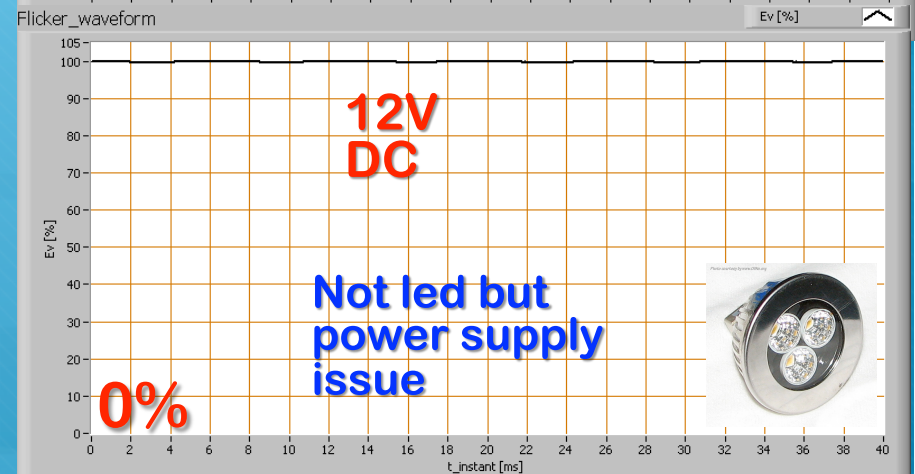
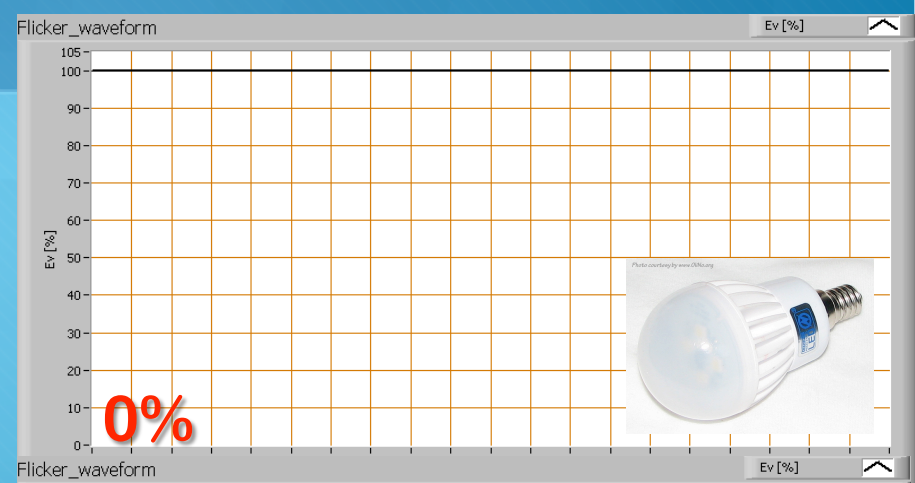
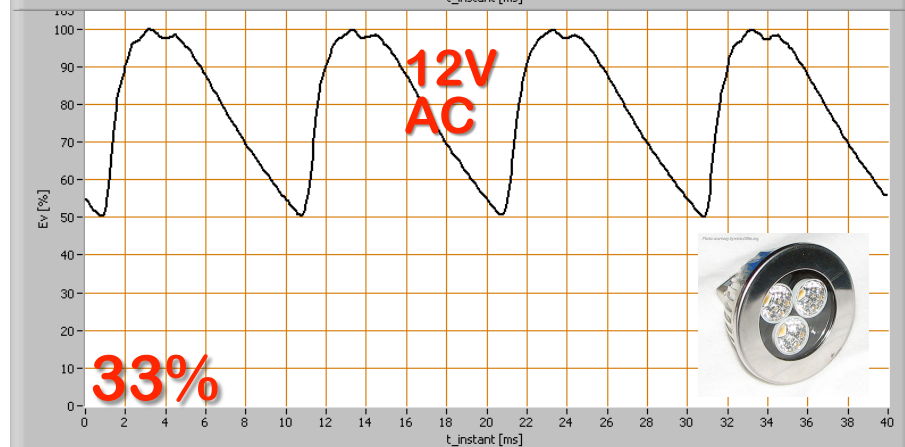
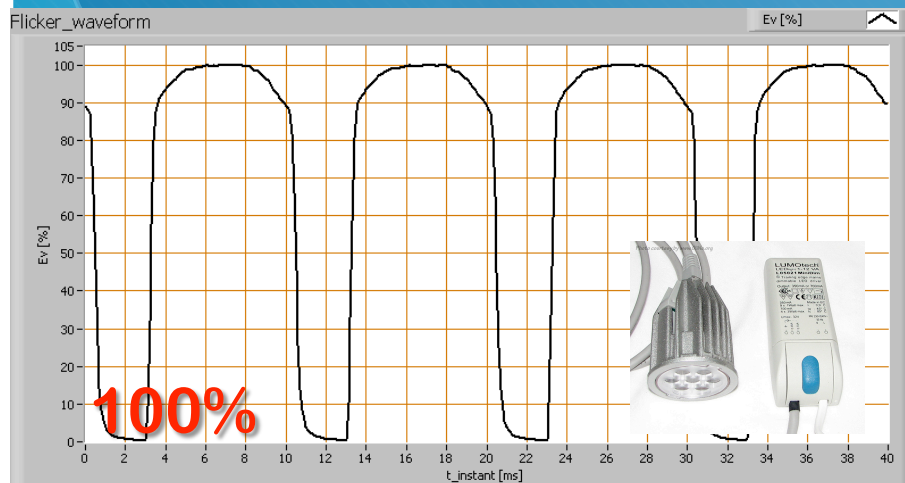
- Modulation index in %



Measurement results



Measurement results



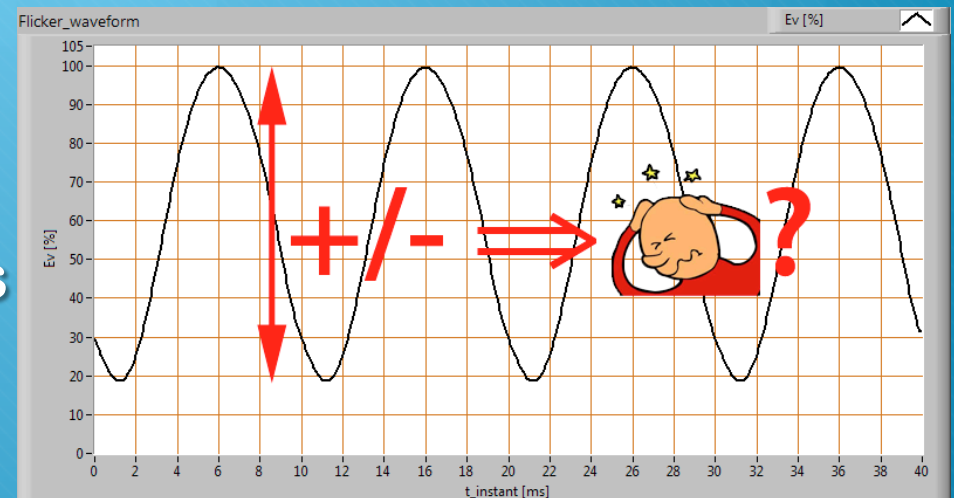
Easy test

- ◊ When high modulation depth \rightarrow stroboscopic effect. Left 0, right 0.55



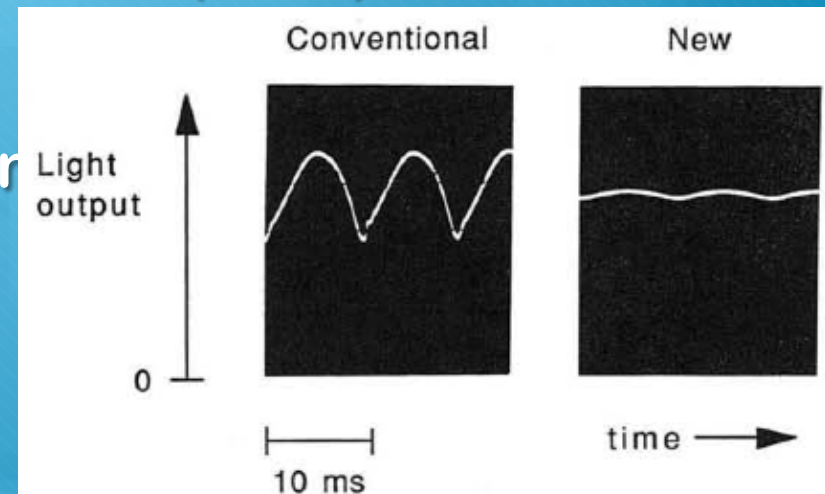
Flicker overview

- ◊ Fast (100 Hz) variations of light intensity
- ◊ Due to power supply/driver → varying output
- ◊ Modulation depth
 - ◊ $\text{=top-top} / 2 \times \text{average}$
- ◊ Can lead to headaches
 - ◊ When $> ? \%$



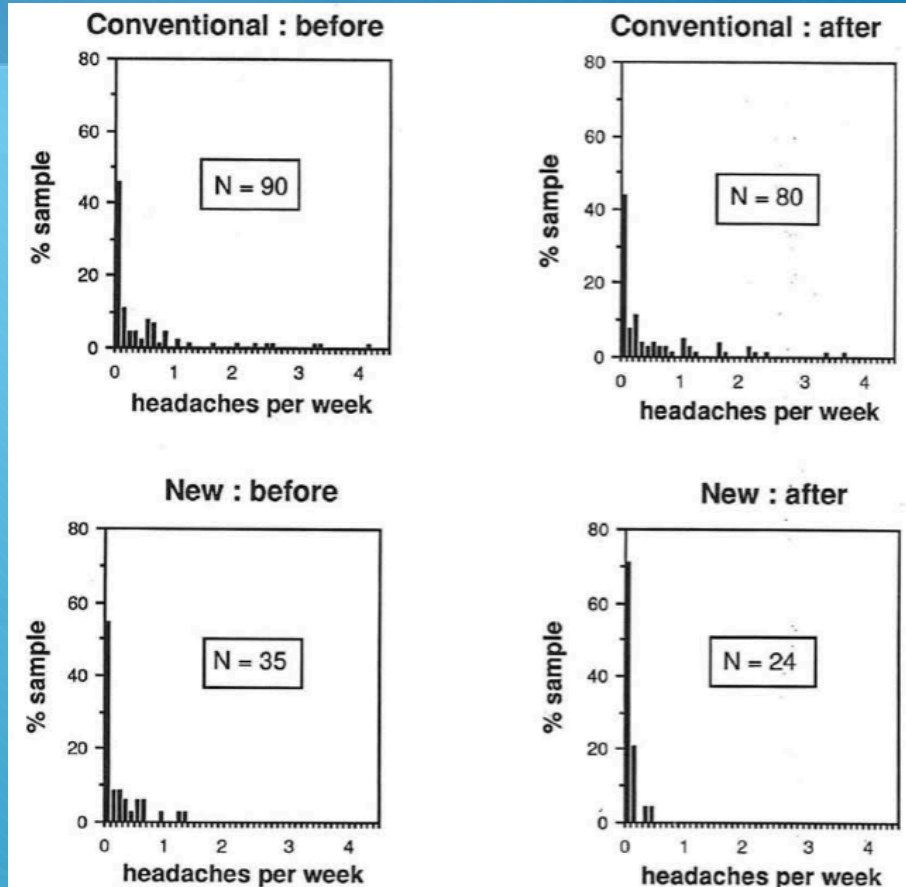
Flicker at lamps investigation

- Study Fluorescent lighting, headaches and eyestrain from 1989
- Fluorescent tubes+choke ballast (45 %) vs tubes + electronic ballast (7 %)
- Exchange of tubes unknown
- Double blind study

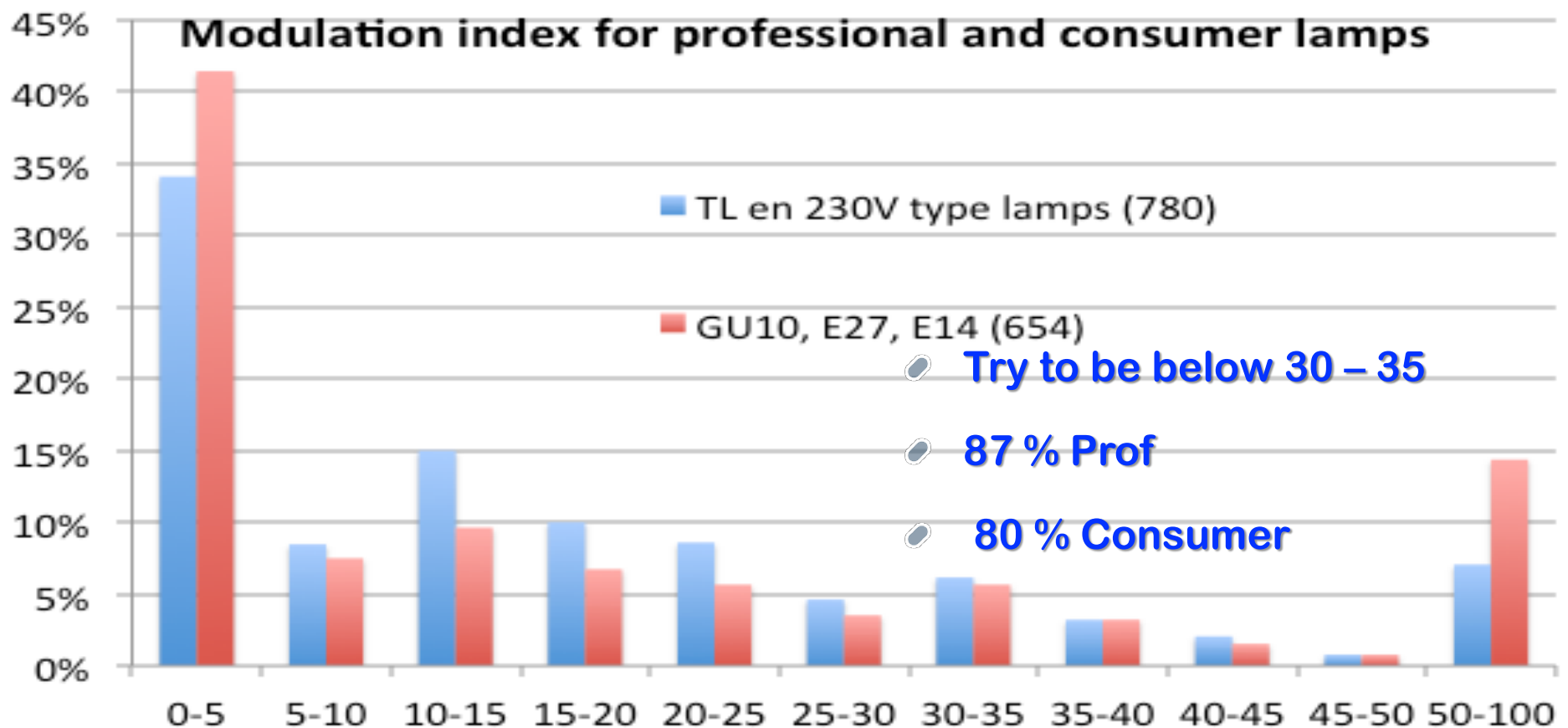


Flicker at lamps investigation

- Amount of eyestrain and nr of headaches were monitored
- New light significantly less initial and after change into
- More natural light (higher levels in building) less headaches

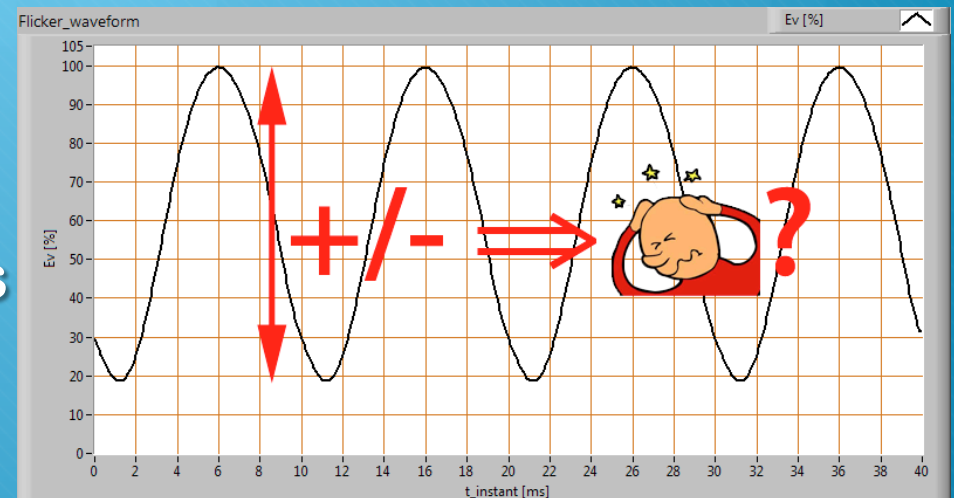


Flicker results



Flicker overview

- ◊ Fast (100 Hz) variations of light intensity
- ◊ Due to power supply/driver → varying output
- ◊ Modulation depth
 - ◊ $\text{=top-top} / 2 \times \text{average}$
- ◊ Can lead to headaches
 - ◊ When $> 35\%$



Articles on OliNo.org

- Flickering:

- <http://www.olino.org/us/articles/2010/04/12/the-flickering-of-light-bulbs>
- <http://www.olino.org/articles/2010/03/09/het-knipperen-van-lampen>
- <http://www.olino.org/articles/2014/01/30/het-knipperen-van-lampen-wat-is-toelaatbaar>