INFLUENCE OF SMART LIGHTING CONTROL ON THE LIFETIME OF HIGH POWER LED LUMINAIRES

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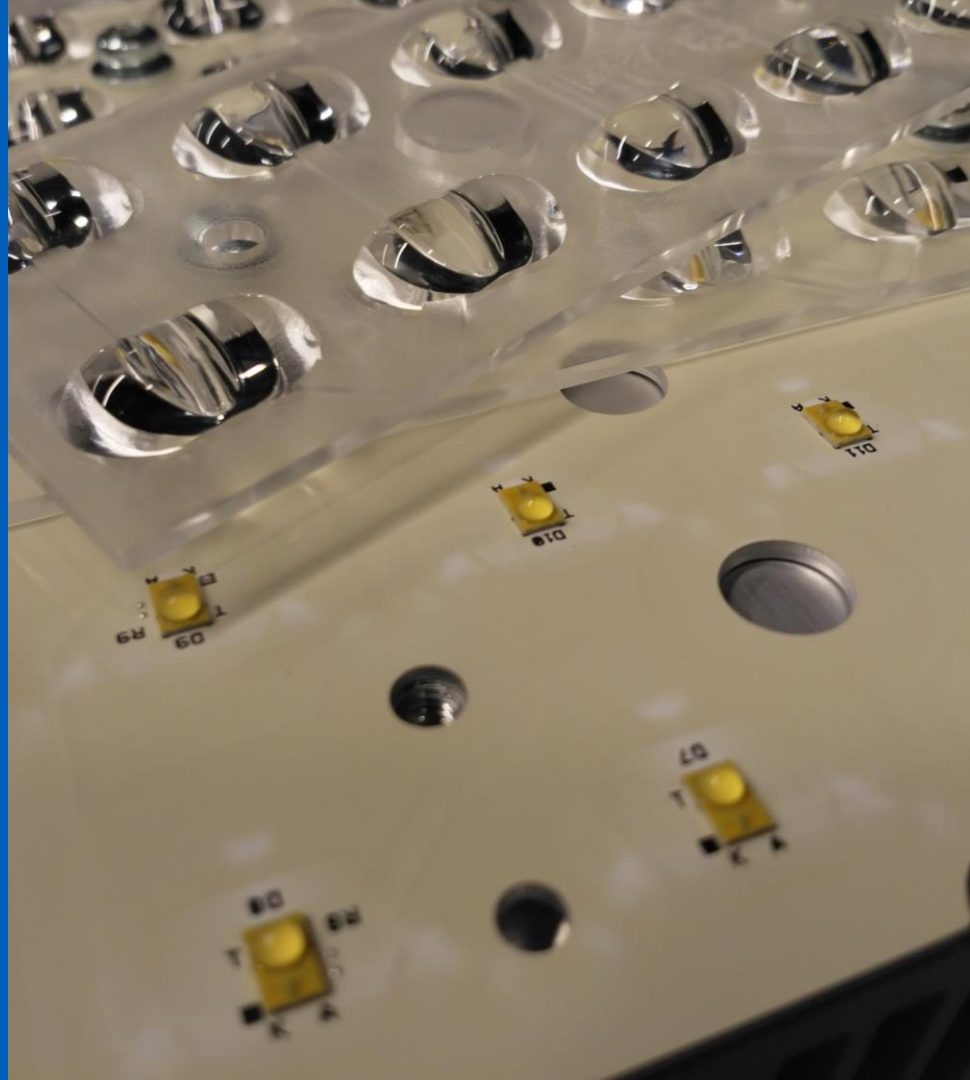


Motivation

- **Traditional street lighting**
  - ON - OFF
- **LEDs enable different usage profiles**
  - Ambient light
  - Occupancy sensing
- **Does this affect lifetime?**

Ageing

- **10+10 luminaires**
  - 2 manufacturers
  - Specified lifetime 100 000 h
- **In laboratory conditions**
  - (25 ± 2) °C
- **5 years of ageing**
  - > 30 000 hours of burn time

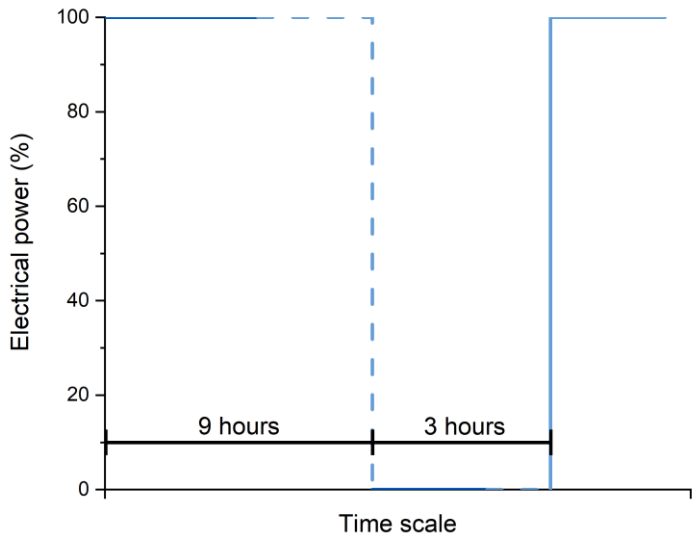
Ageing cycles

- **Cycling increases lifetime?**
  - Average LED junction temperature smaller
- **Cycling decreases lifetime?**
  - Hammer testing in electronics
- **Approximately 100 dimmings per daily cycle by simulation[1]**

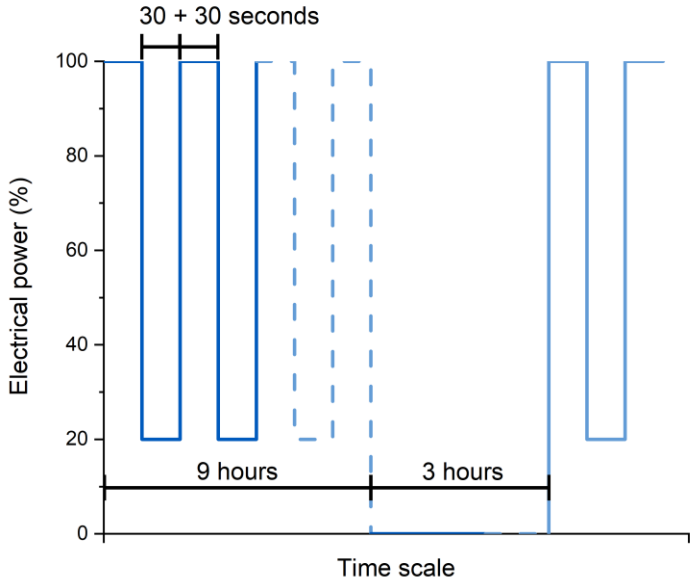
[1] S. P. Lau, G. V. Merrett, A. S. Weddell, N. M. White, A tracaware street lighting scheme for Smart Cities using autonomous networked sensors, Computers and Electrical Engineering 45 (2015) 192–207.

Ageing cycles

- **Natural ageing**

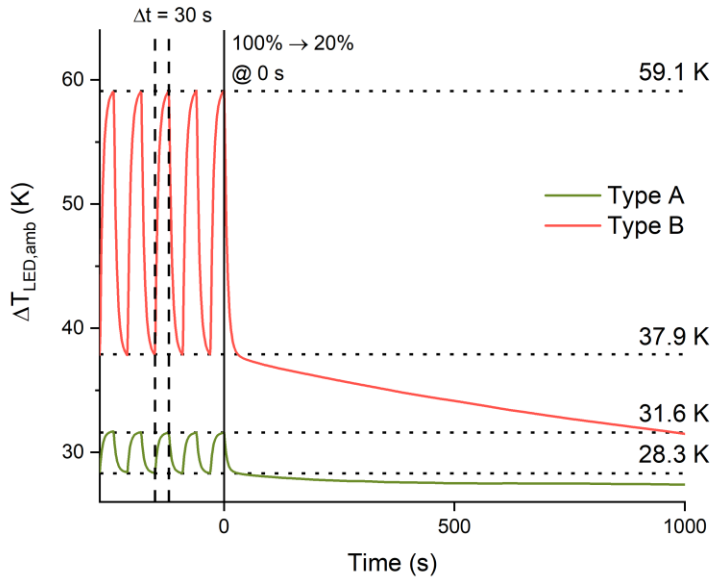


- **Adaptive control ageing**



Temperature profile due to adaptive ageing

- **Temperature measured right next to LED chip**
- **30-s cycle selected to maximize the thermal stress**
  - worst case scenario

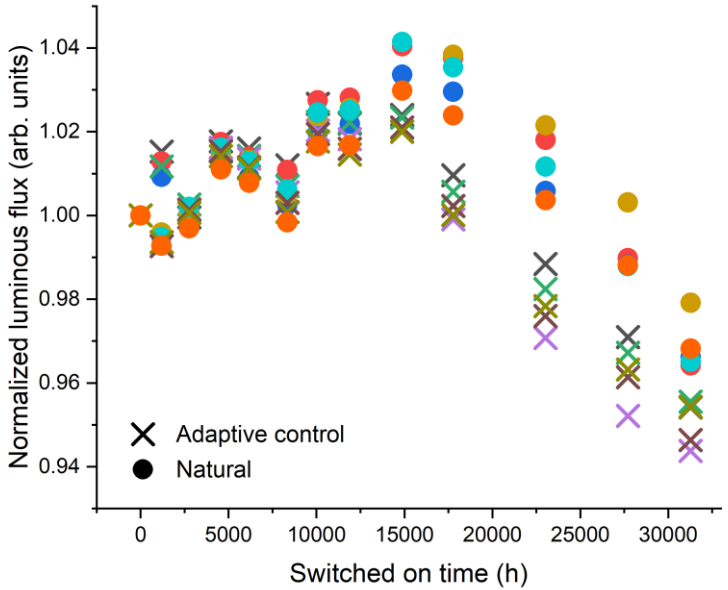


Measurements during ageing

Luminous flux

- **Measurements in integrating sphere**
  - Uncertainty < 2% (*k* = 2)
- **Type A adaptive controlled age faster than natural aged**

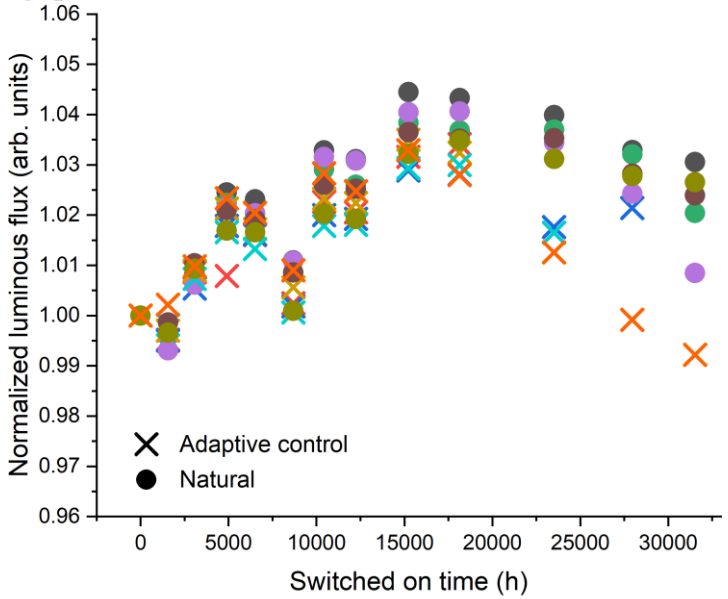
Type A



Luminous flux

- **Measurements in integrating sphere**
  - Uncertainty < 2% (*k* = 2)
- **Type A adaptive controlled age faster than natural aged**
- **Type B adaptive controlled fail (4/5) before 30 000 hours**

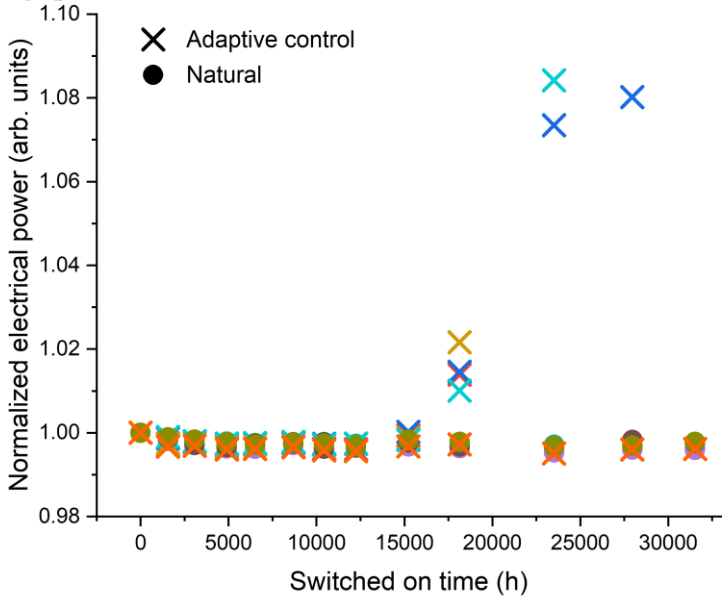
Type B



Electrical power

- **Type B adaptive controlled luminaires begin to consume more power after 15 000 hours**
- **In Type A luminaires no abrupt changes**

Type B



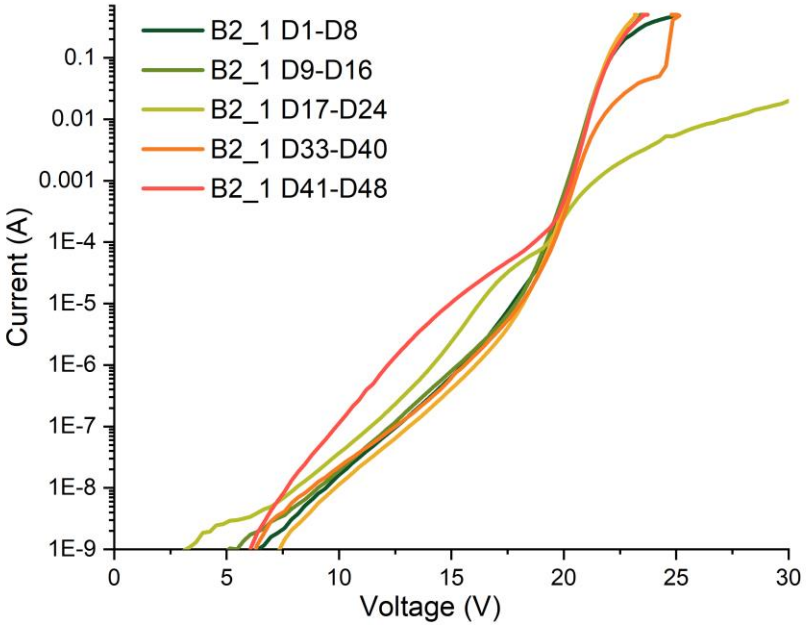
Lifetime estimation

- **L_{70} (31k) by IES TM-28-14**
- **Type A luminaires**
  - ~110 000 hours natural
  - ~100 000 hours adaptive control
- **Type B luminaires**
  - > 150 000 hours natural
  - Adaptive controlled break down

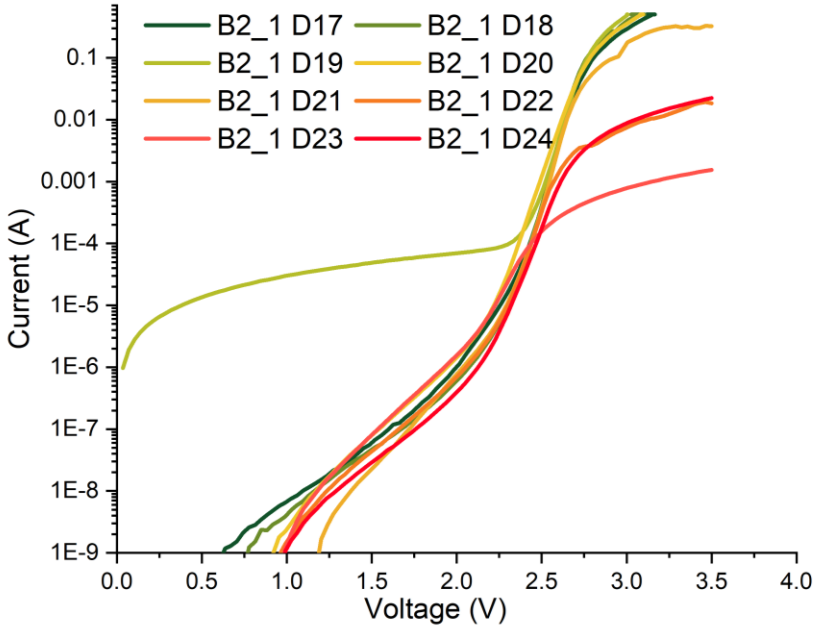
IV-curves of LEDs

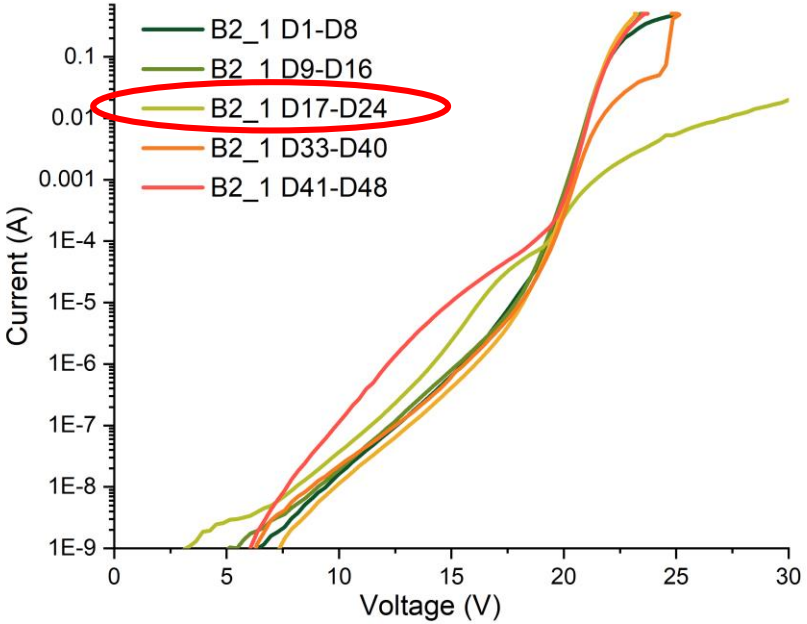
IV-measurements of LED chips

- **IV-curves of LED sub-arrays and single LEDs measured**
- **Type A luminaires in 4 different series**
- **Type B luminaires all LEDs connected in series**



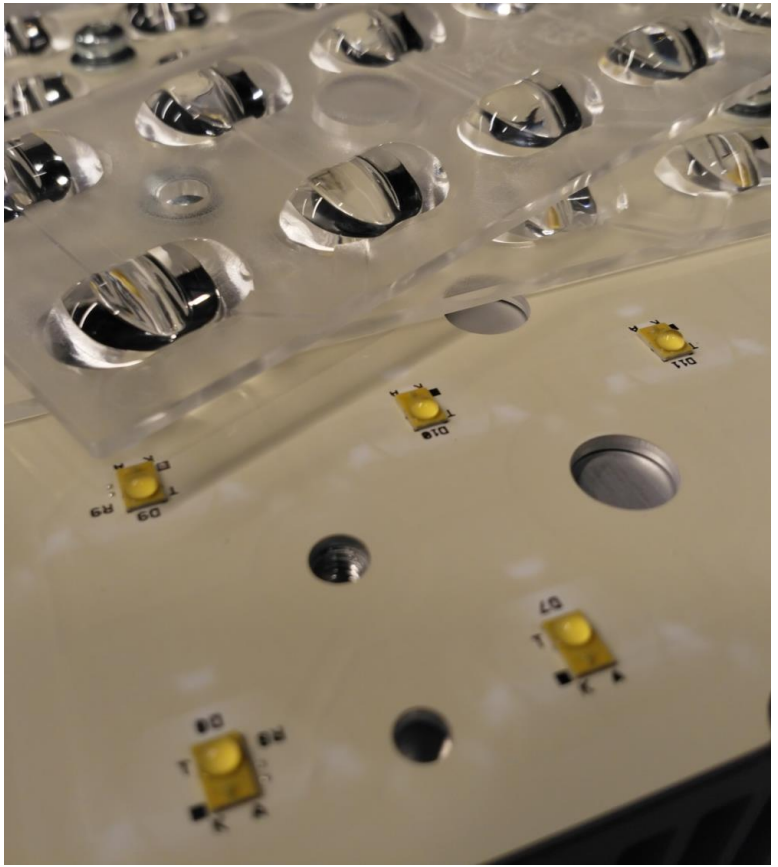
IV-measurements of LED chips





Conclusions

- Adaptive controlling might affect luminaire lifetime
- Should be taken into account in designing new installations
- Temperature design of the individual luminaire important
- Parallel LED series



Thank you!