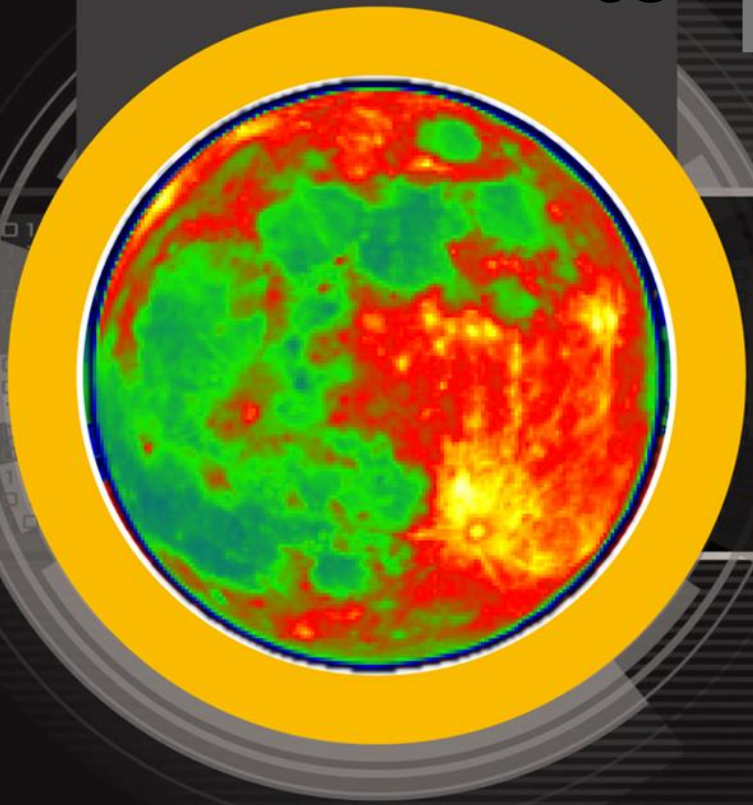
BRNO UNIVERSITY OF TECHNOLOGY

FADE to BLACK in BRNO



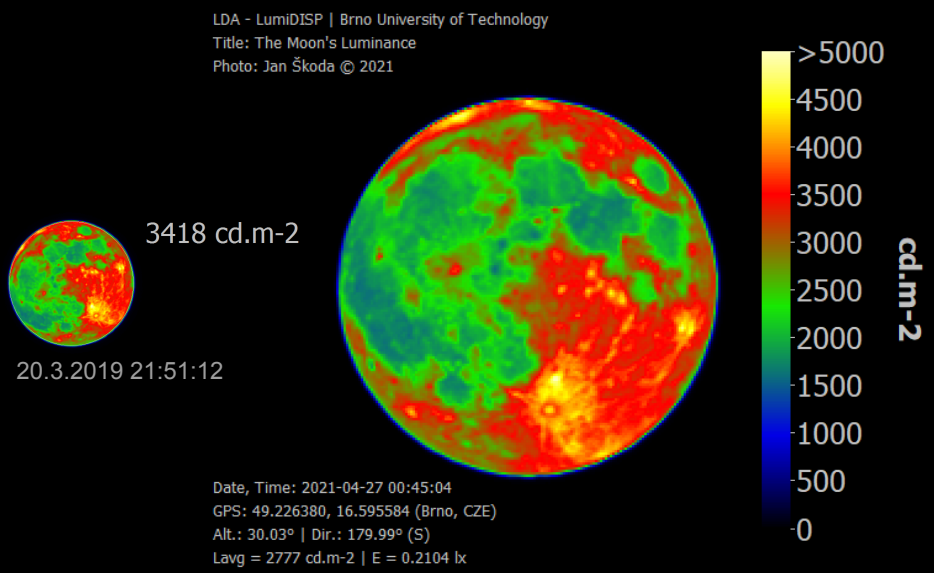
HOW WE MEASURED ALAN?

Assoc. Prof. Ing. **Petr Baxant**, Ph.D.

Faculty of Electrical Engineering and Communication
Department of Electrical Power Engineering

Technická 12, Brno, Czech Republic

Natural light as standard



In the night environment, the **Moon** can be considered the brightest object of the natural origin.

The luminance of the **Moon** changes with position and at full moon we can measure an average value of eg. 3500 candela per square meter (cd.m^{-2}).

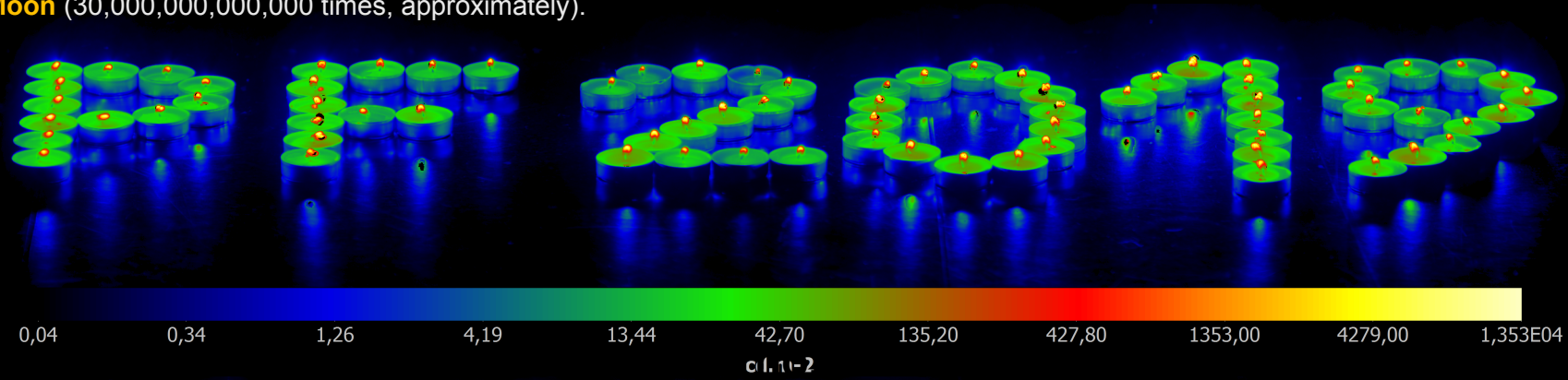
At a distance of the Moon on average 384.000 km this cosmic object will create an illumination lower than **0,25 luxes (lx)** on the Earth's surface. This is the reflected light of the Sun.

Compare: sunny day 100 000 lx = 400 thousand times higher surface illumination than night at the full moon.

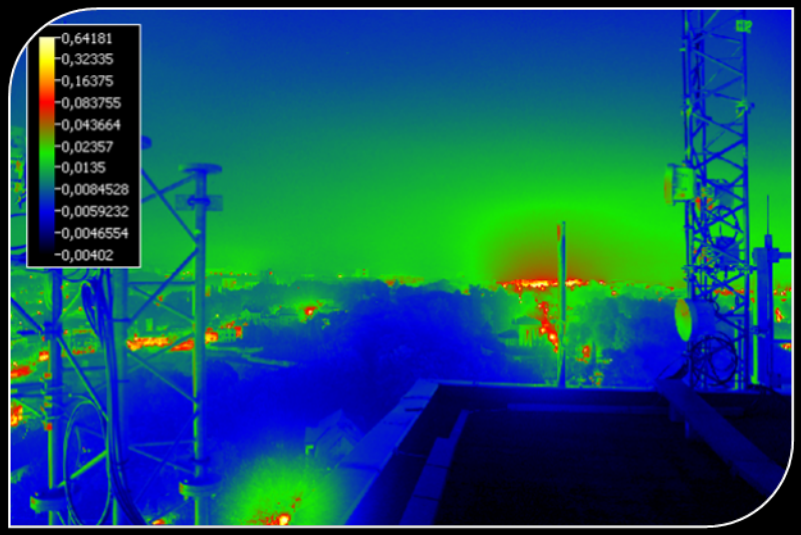
The natural night is very dark compared to the time of day.

In the time between full moons, these are ratios greater than **1:1 000 000!**

The **flame of the candle** has a luminance approximately the same as the surface of the **Moon**, the maximum range up to 13,500 candelas per square meter. However, the light intensity of one candle is 30 billion times less than the light intensity of the entire **Moon** (30,000,000,000,000 times, approximately).



12 years before…



Light pollution is the topic that is currently being discussed in many forms, both on a professional and a lay platform. The link between human activity and its impact on the environment is obvious, but an acceptable "measure" is still being sought.

How much can we afford to shine and with what?

*Already in **2009**, the largest experiment ever conducted in the Czech Republic was carried out, when the luminance of the night sky was analyzed when a substantial part of public lighting in the entire Liberec region was switched off.*

The picture above shows a photo of the night environment when operating under public lighting.

The bottom image then shows the luminance map, the luminance values converted to the objective reality - numbers.

and Light Pollution measurement

The luminance analysis of the night sky with the public lighting switched off clearly shows the effect on the luminance of the sky, not only in visual view (upper picture), but of course also in numerical form expressed photometrically using a luminance map obtained by calibrated luminance analyzer.

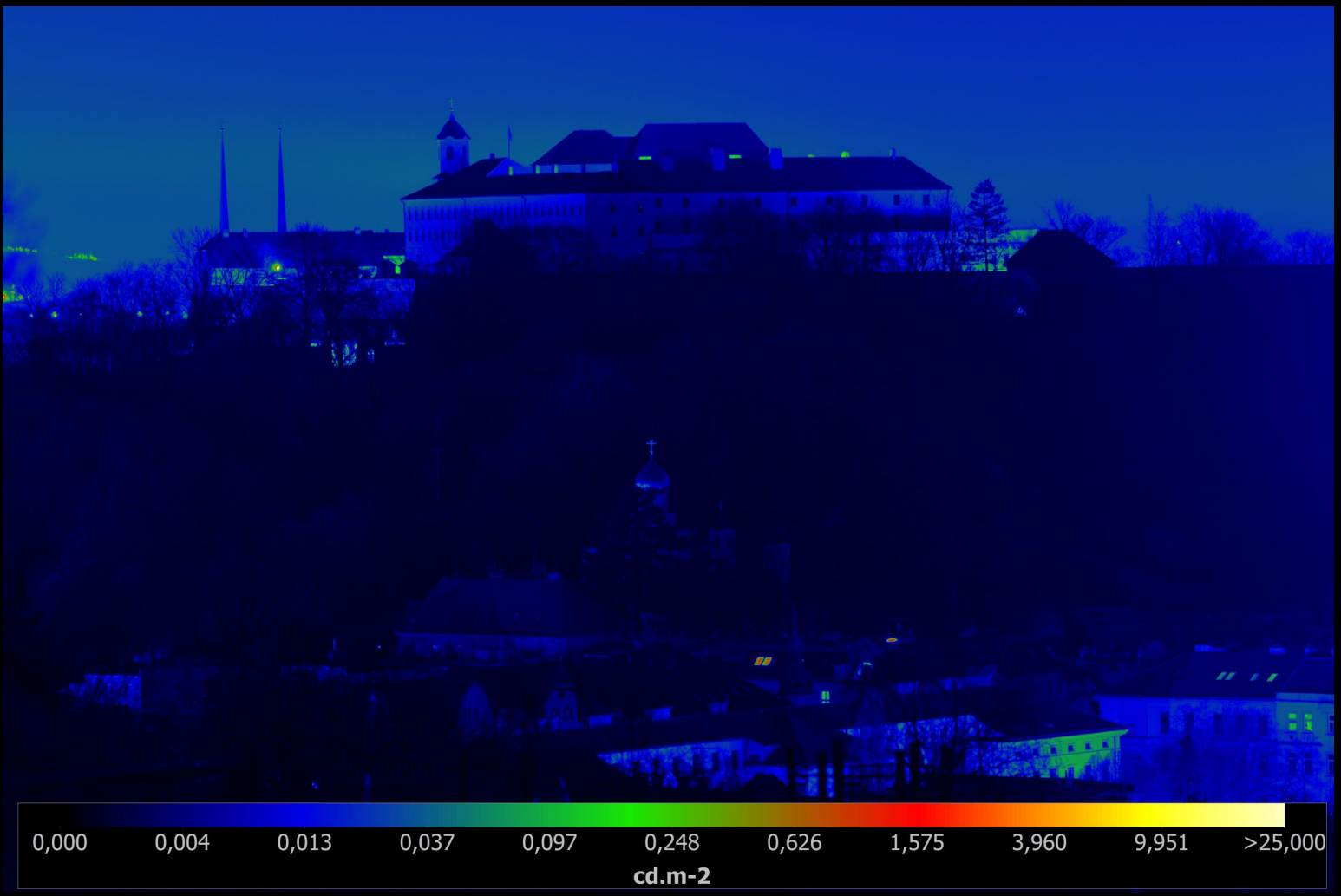
The same color palette was applied to this "dark" image of the sky without public lighting. In the distance, the only major city remained lit, and its contribution to the luminance of the night sky is evident.

(Or slight?)

The luminance of the sky here is in the order of thousands of candelas per square meter, ie a ***million times less than the luminance of the Moon****.*

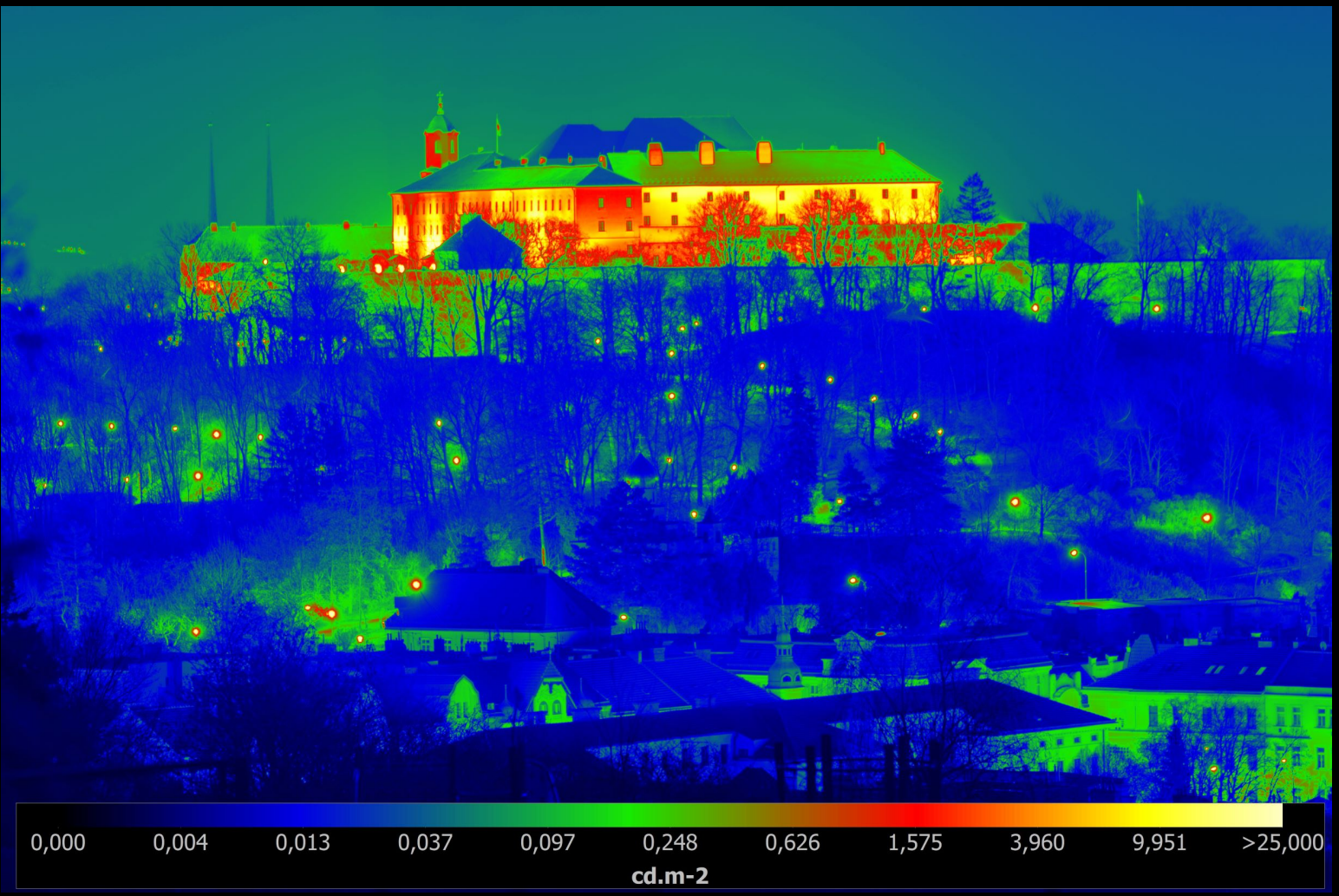
Although complete darkness was not reached, ***the luminance of the sky dropped to about a quarter****.*

… and 2021 in Brno - Spilberk castle



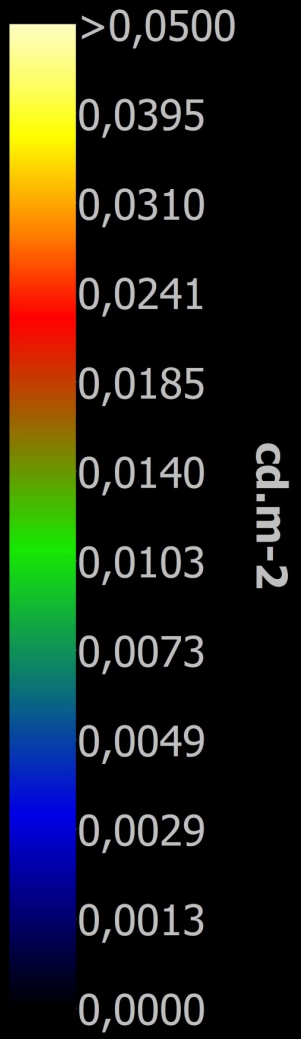
Castle facade in the darkness. All the public lights in the city were switched **OFF**
(42 000 of lamps)

Spilberk castle - lights ON



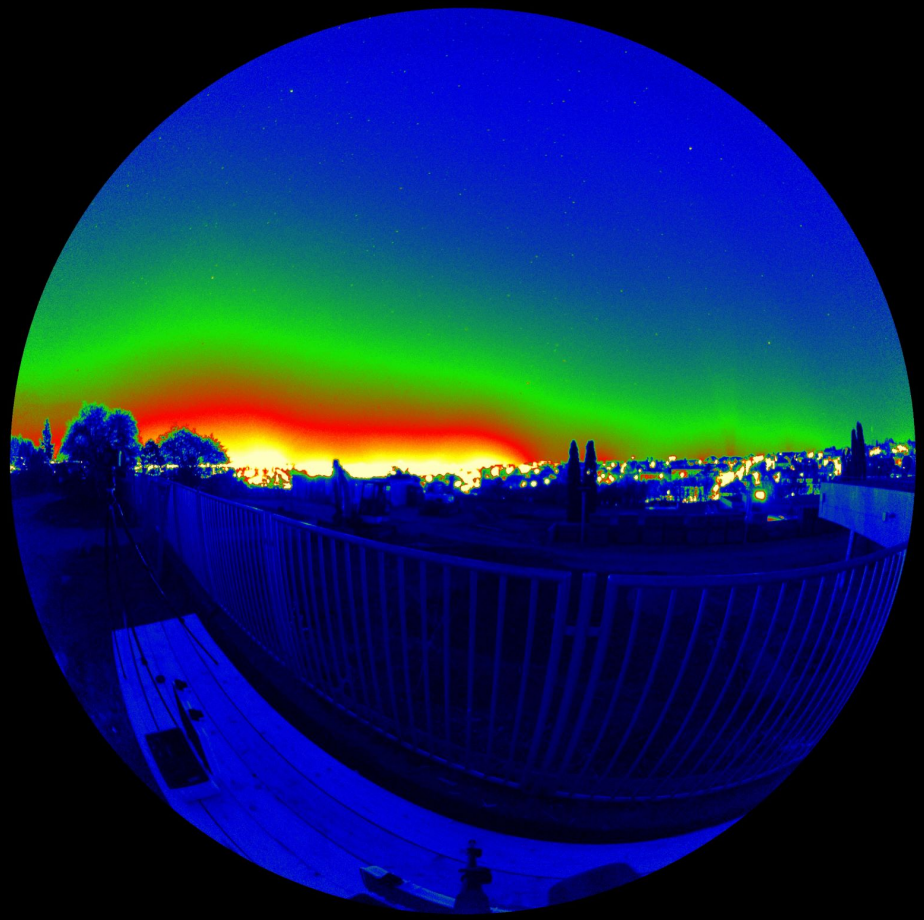
Castle facade in the light. Public lights and architectural lighting in the city were switched **ON**

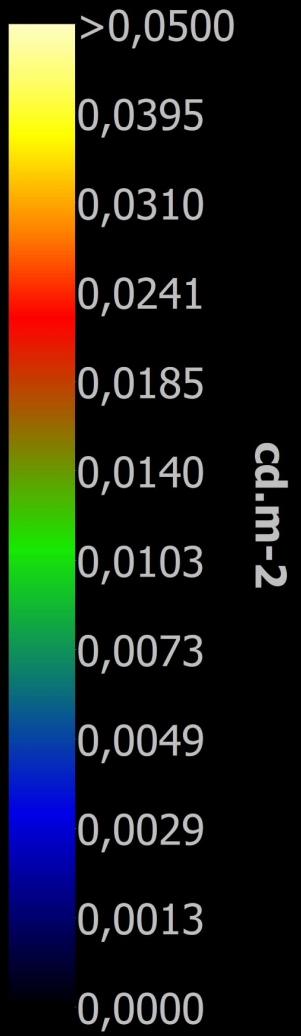
FishEye view to the city center



On the horizont there are visible reflectors, shining directly to the sky. And lot of other commercial lights. Left on the sky there is line created by scanning plane. Public lights are **OFF**.

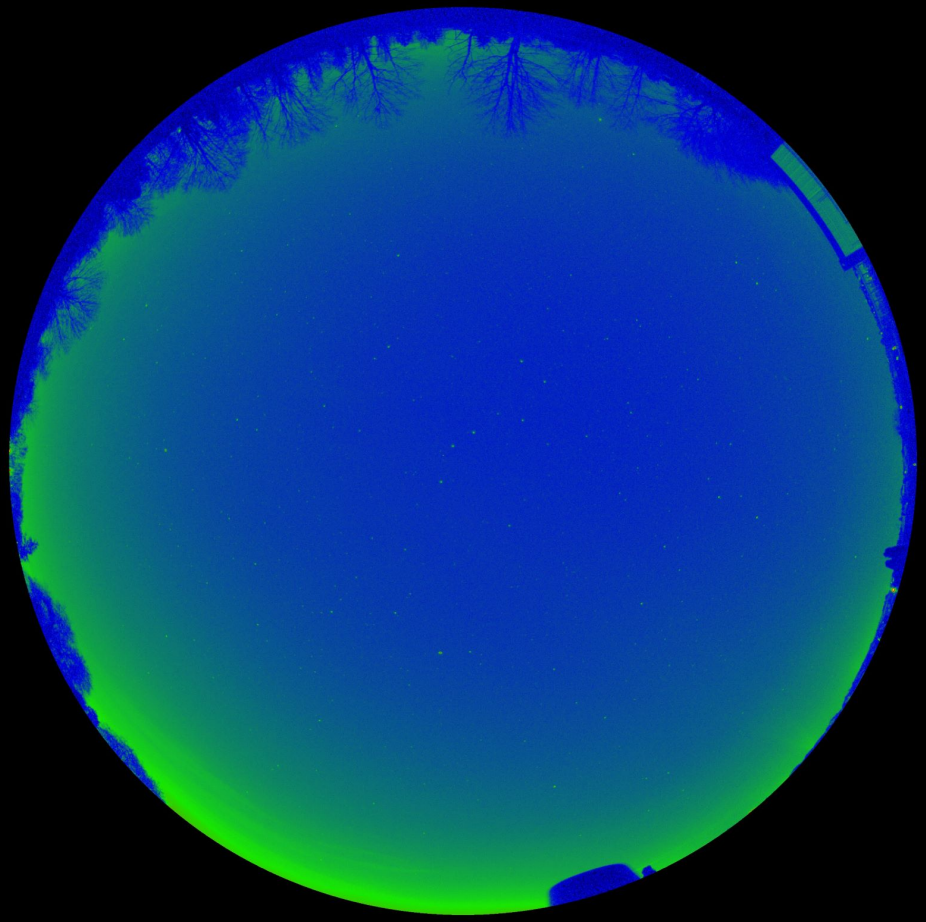
FishEye view to the city center

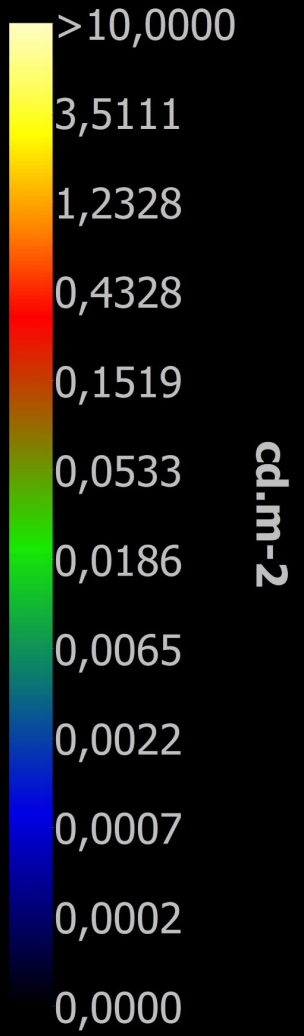




When public lights is **ON** the sky luminance on the horizont raising so much, that reflectors light contrast is under visible level.

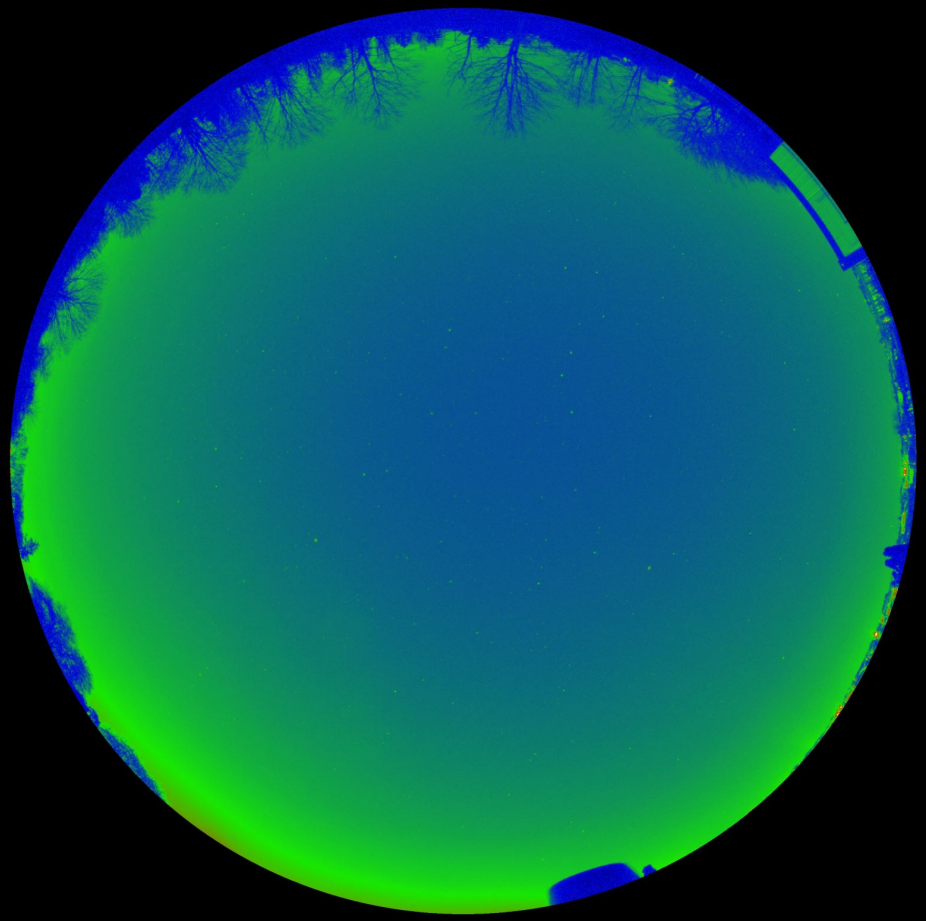
FishEye view to the zenit

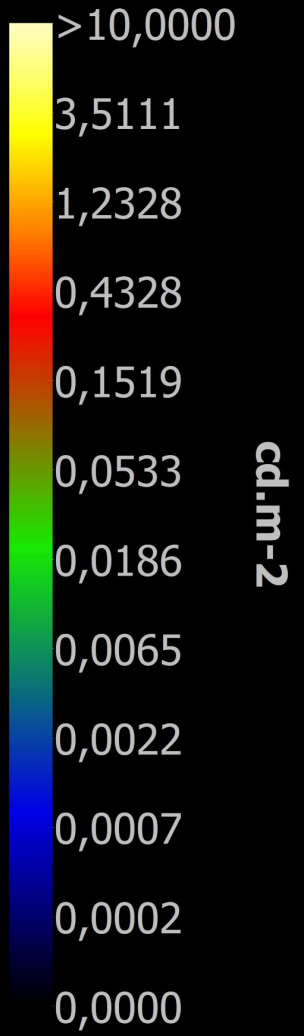




Sky dome luminance with public lights **OFF**.

FishEye view to the zenit

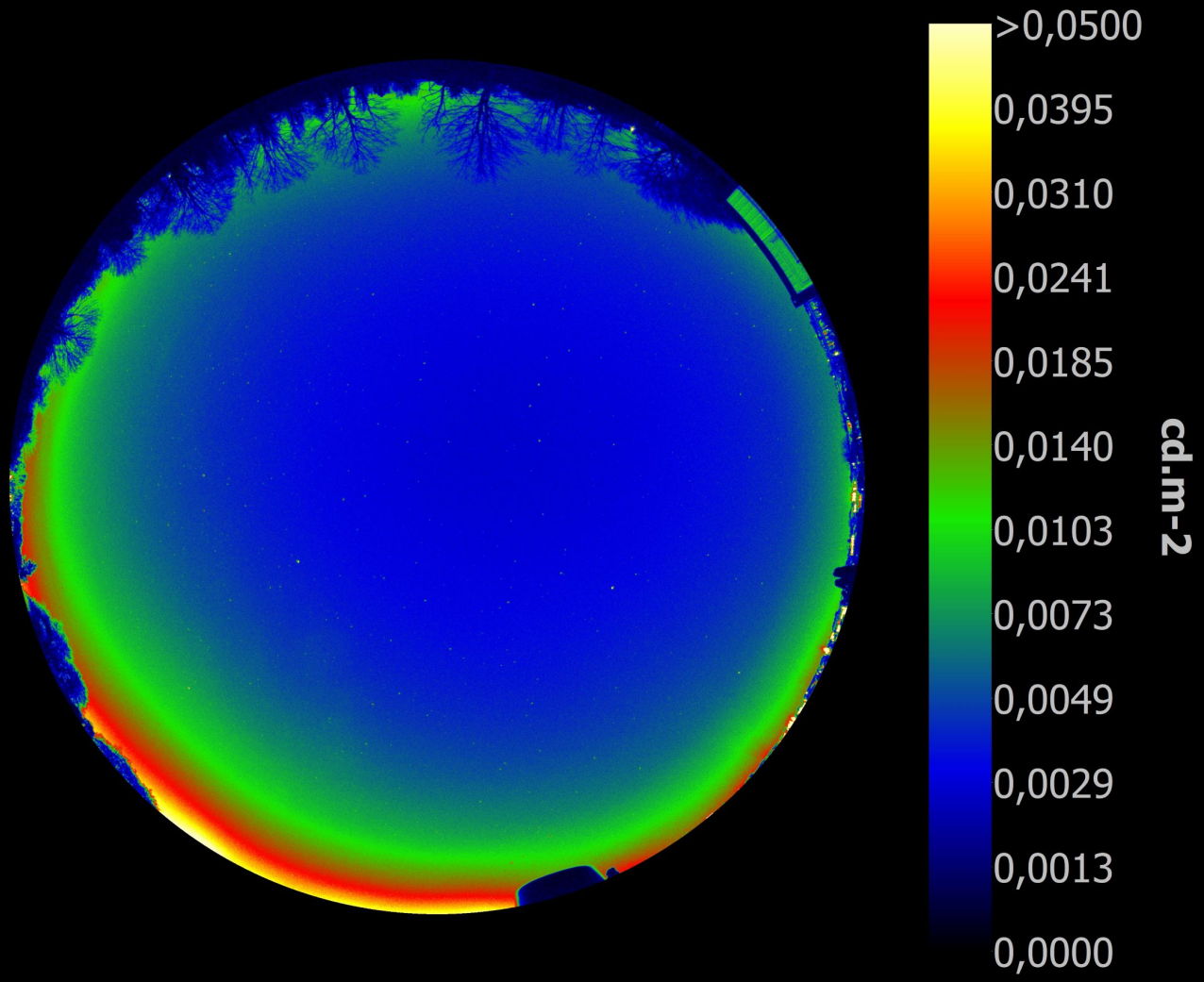




Sky dome luminance with public lights **ON**.

FishEye view to the zenit

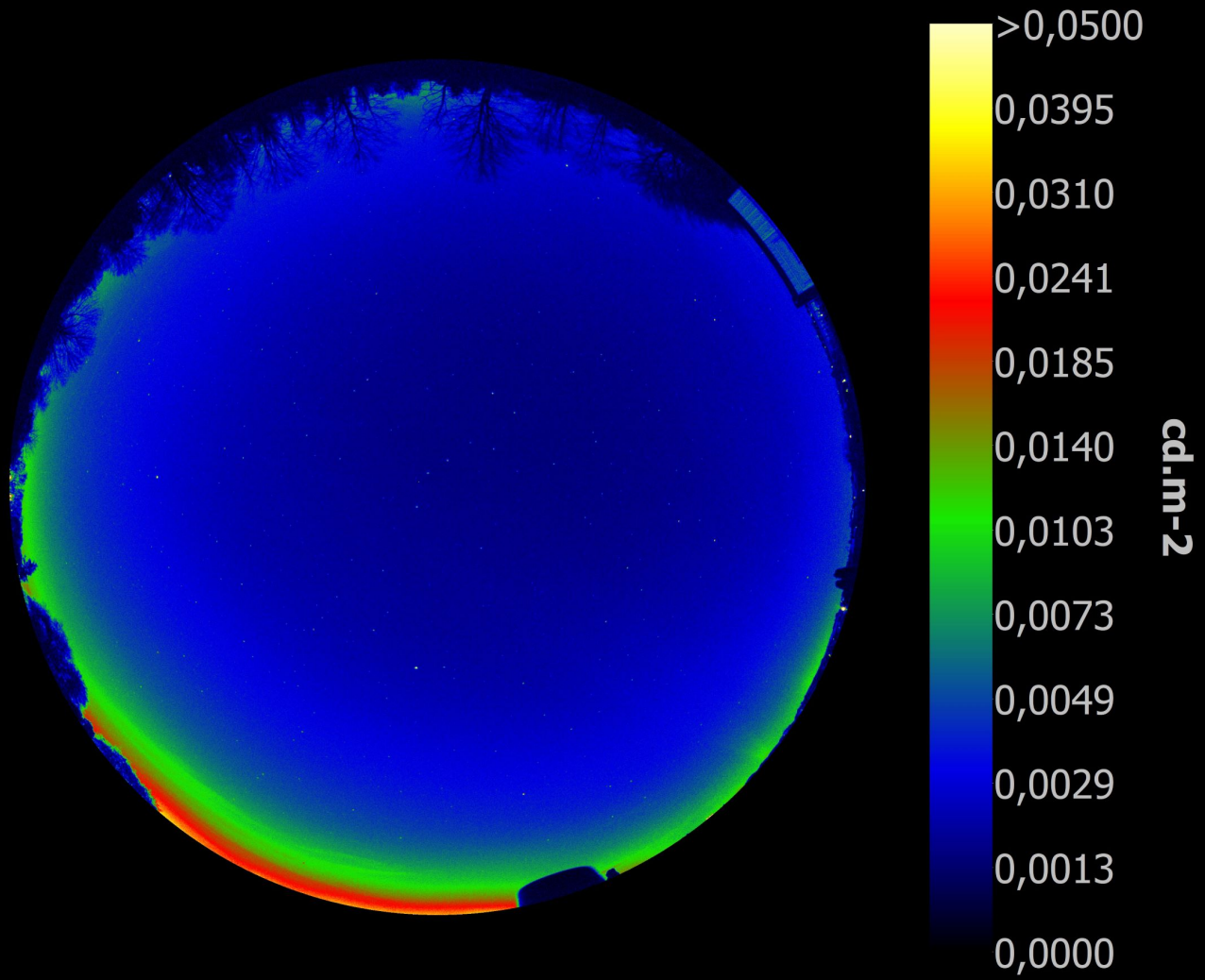
- other luminance scale - to highlight horizont light



Sky dome luminance with public lights **ON** with other luminance scale - to highlight horizont light.

FishEye view to the zenit

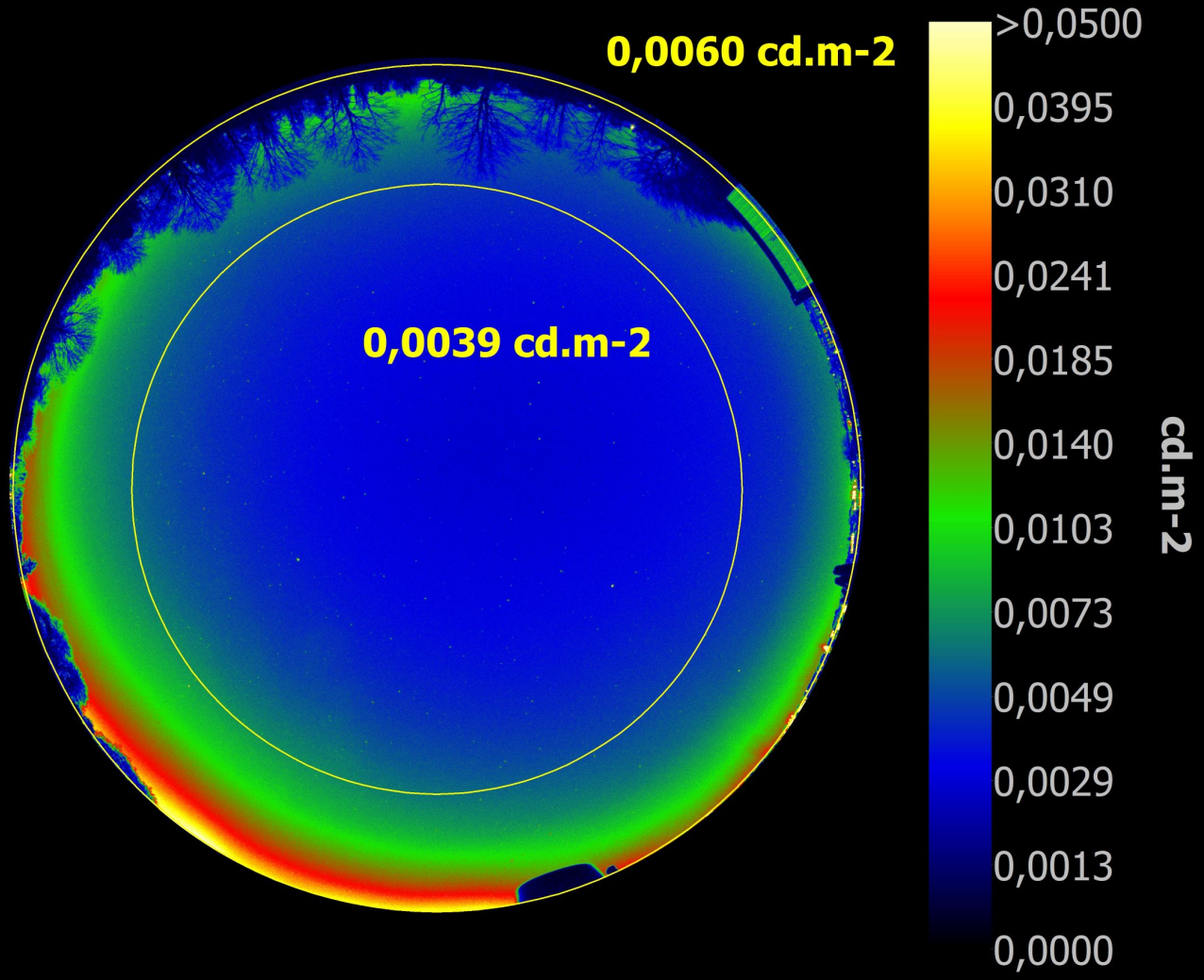
- other luminance scale - to highlight horizont light



Sky dome luminance with public lights **OFF** with other luminance scale - to highlight horizont light.

FishEye view to the zenit

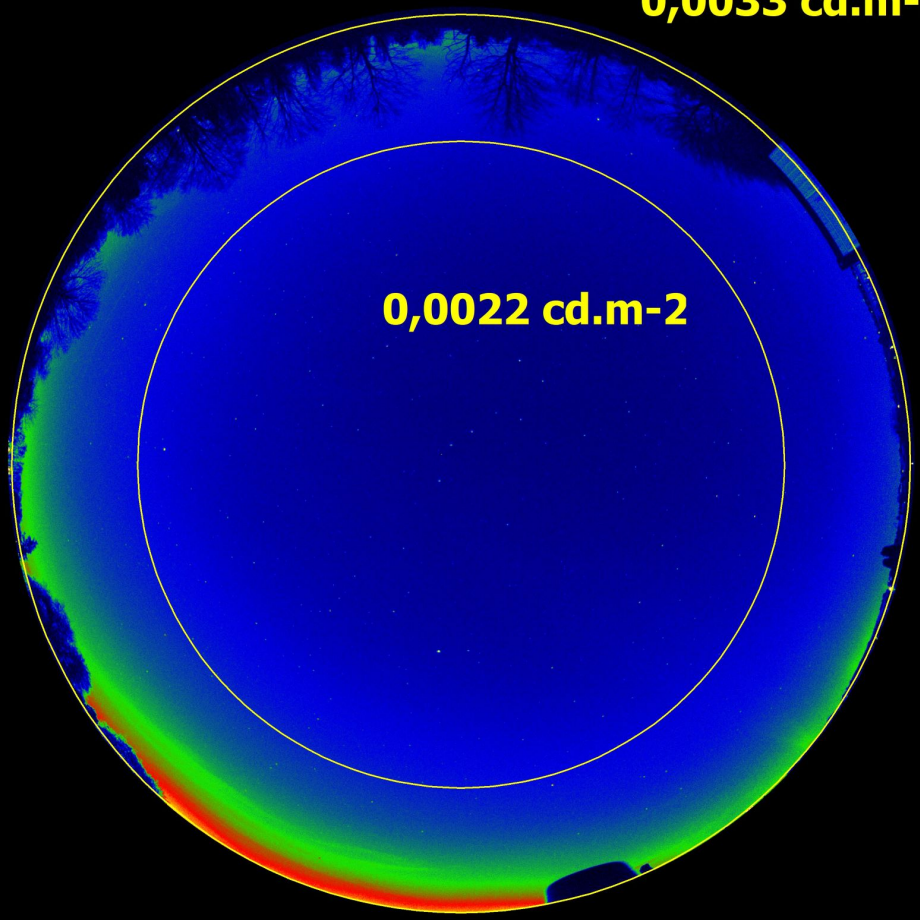
- average luminance measurement

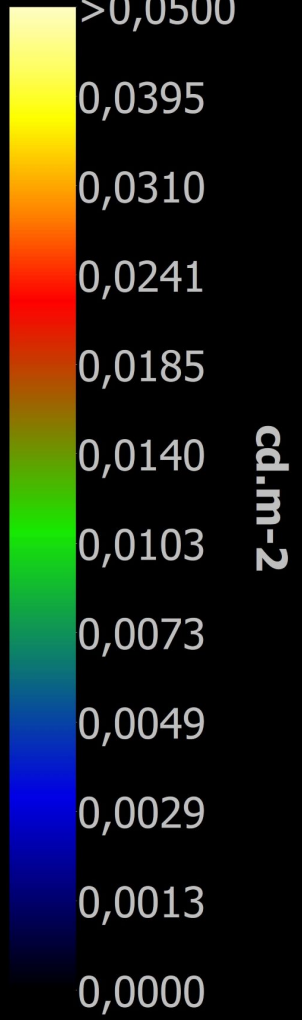


Inner circle represent 120 degrees conus and outer circle represents 178 degrees conus. Average luminance are indicated inside the circles.
Public lights **ON**.

FishEye view to the zenit

- average luminance measurement





Public lights **OFF**.

Conclusion

- ***Circle radius 60 deg from zenit***
  PL OFF: 0,0049 lx / 0,0022 cd.m^{-2}
  PL ON: 0,0088 lx / 0,0039 cd.m^{-2}
  Increment OFF to ON: 79,5%
  Decrement ON to OFF: 44,3%

- ***Circle radius 89 deg from zenit***
  PL OFF: 0,0080 lx / 0,0033 cd.m^{-2}
  PL ON: 0,0142 lx / 0,0060 cd.m^{-2}
  Increment OFF to ON: 77,5%
  Decrement ON to OFF: 43,6%

- *We are in the beginning of ALAN measurement.*
- *We will looking for the proper method, how to visualize very wide range of light scenery.*
- *We must find any realistic indicator, how to qualify and quantify ALAN.*
- *It is necessary develop new devices for very sensitive and fast scanning directly from the street, terrain.*
- *Actually it is quite long and complicated express proper data from night sky, night environment.*
- *We are working on improvement and our mission is help to the scientist have an objective data about the light at night, not only in a visual spectrum.*

What are we missing?

A cut-out of the same scene taken from the Jizera region of the dark sky is digitally inserted into the film The Milky Way by the author **Petr Horálek**. Due to the veiled brightness of light from nearby cities, many space objects disappear from view. **Similarly, life on our planet is disappearing, but we often do not realize it.**

Ref: https://www.astro.cz/clanky/svetelne-znecisteni/nalezneme-u-nas-tmavou-obloze.html

People and contacts

Research and development of luminance measurements is currently handled by the workplace of the Department of Electrical Power Engineering and the lighting technology laboratory.

Leader and guarantee of the project
Doc. Ing. Petr Baxant, Ph.D.

Hardware platform and calibration
Ing. Jan Škoda, Ph.D.

Measurement uncertainty
Ing. Martin Motyčka, Ph.D.

ALAN research
Bc. Filip Novák

Software platform
Ing. Stanislav Sumec, Ph.D.

BRNO UNIVERSITY OF TECHNOLOGY

Brno University of Technology
Faculty of electrical engineering and communication
Department of Electrical Power Engineering
Technická 12, 616 00 Brno,
Czech Republic

www.lumidisp.eu

Copyrights and acknowledgement

The development of measuring methods and devices takes place in the Center for Research and Utilization of Renewable Energy Sources (CVVOZE). The authors thank the Ministry of Education, Youth and Sports for financial support from the FEKT-S-20-6449 program.

Special thanks

Authors specially thank to the following partners, who realize and help the switch off the public lighting for the experiment in Brno city to obtain this crucial data

Brno City Municipality

Technical Networks Brno

Brno Observatory and Planetarium