Report on activities of the Czech Section of the International Dark Sky Association in 2004 and 2005

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January 30, 2006

1 Summary

In 2004 and 2005, the Czech section of the IDA worked quite a lot on legislation and education, but the main activity was the research. Due to "demand side", most outputs are available in Czech only. The occasional English remarks are linked to in the following text. Let's remember that our main info in English is at `www.astro.cz/darksky` – unfortunately not at all so up-to date, as this Report tries to be.

2 2004

The first half of 2004 has been mentioned in our previous report already, *Czech IDA section report on 2003* `amper.ped.muni.cz/jenik/letters/public/msg00220.html`, namely the results of our research – they have been published in winter of that year. Some minor corrections within the main report and its parts have been made since and the directory `amper.ped.muni.cz/noc/` updated accordingly. The state of our knowledge at that time and future research goals are summarised within our (unsuccessful) grant application, available as (pdf is there too) *Light as a Pollutant of the Night Environment: reality,impacts, remedies. Description and Substantiation of the Project submitted to the Czech Science Foundation* `amper.ped.muni.cz/noc/english/res_plan2004.html`.

2.1 Health damage from man-made light at night

In April 2004, we have submitted four abstracts (`amper.ped.muni.cz/noc/english/Can_and_Rhythm.htm`) to the Cancer and Rhythm conference to be held in October. They have been accepted as posters (all oral presentations were invited ones).

In August, I was invited to participate in an: *International Scientific Conference on Childhood Leukaemia – incidence, causal mechanisms and prevention, Westminster, London, 6 - 10 September 2004* `leukaemiaconference.org/`.

I prepared a poster summarising our research results, its abstract is `amper.ped.muni.cz/noc/english/leuk_conf/cz_light.htm`, the very poster being `amper.ped.muni.cz/noc/english/leuk_conf/post_jh.pdf`. It appeared I was the only participant concerned with general protection of night environment against man-made light; however, many participants were concerned with possible causal link between too much light and childhood leukaemia, and the key researchers at the field issued serious warnings in the media, see the conference pages or my posting *Articles on Childhood Leukaemia* `amper.ped.muni.cz/darksky/2004/000069.html`. For me, the most convincing paper was by Sam Milham, on the rise of incidences a few years after electrification in the US (our interpretation differs from his: not 60 Hz magnetic field, but rather light at night is the probable cause). I've exchanged two letters on this with Ken Campbell, the very paper is hyperlinked to at the end of the first one: `amper.ped.muni.cz/jenik/letters/public/msg00149.html`, `amper.ped.muni.cz/jenik/letters/public/msg00150.html`.

Shortly after the conference, mentioning it within *[DSLF] Digest Number 1449* amper.ped.muni.cz/jenik/letters/dsa/msg00068.html I was asked by David Keith to propose a formula for metabolic-efficient light. So I did, announcing it within *"Cancer and Rhythm" – please register* amper.ped.muni.cz/darksky/2004/000068.html

The formula has been presented at the next conference in Graz, three of our four posters are inside amper.ped.muni.cz/noc/english/canc_rhythm/ (the remaining one, on blood pressure is not online). Our poster g_camer.pdf was not the only one devoted to measuring metabolic-efficient light, but the only one showing how to measure them with common digital cameras, mentioning the tolerable levels and the need and ways of filtering out the shortwave half of the spectrum.[1] One of another posters gave a reference to the smooth action spectrum curve proposed earlier already (based on papers from just two teams, not all the three ones), within *Gall, D.: Die Messung circadianer Strahlungsgrößen. Tagung Licht und Gesundheit 26. bis 27.2.2004 Berlin* www.tu-ilmenau.de/site/lichttechnik/fileadmin/template/fglt/publikationen/2004/Vortrag_Gall2004.pdf

Two of our posters were devoted to another aspects of light than to reducing melatonin production: rising the blood pressure and disturbing sleep. The last one alone is a serious reason for urgent adaptation of all outdoor lighting.

Thomas Posch (Austrian IDA section) wrote a *Graz conference report*, amper.ped.muni.cz/jenik/letters/public/msg00183.html

(Since October 2004 we filter out shortwave half of light at night at home, using either pure yellow linear fluorescents, yellow glass paint or yellow self-adhesing, well translucent foil. It's a pleasure to everybody, being really cosy, and in fact inevitable for your good conscience, if you become aware that light at night becomes a poison at most common indoor levels but the lowest ones.)

2.2 Monument lighting and the limits for it

The case of Boston Stump church lighting, which damages the night view of England (raised by Darren Baskill within the CFDS forum), moved me to study this phenomenon further. The result is surprisingly simple: any church illuminated to levels over $1\,\mathrm{cd/m^2}$ becomes an unpleasant dominant when seen from the space (of course not the church, just the lights around it). See the most relevant letter, *Earth from above (continuing "for your amusement")* amper.ped.muni.cz/jenik/letters/public/msg00152.html:

> "Moreover, a general conclusion follows: any luminance higher than one candela per square metre, for tall buildings with tops bathed in the upward stream of light, results inevitably in spoiling the view of the Earth from the universe, if the viewers come into the beam. The larger the beam cone, the larger the cone in the space from which the view is spoiled..."

Earlier explanations on architectural and park lighting have been published as *Re: A monumental lighting task* amper.ped.muni.cz/jenik/letters/public/msg00137.html and *Cathedral near Observatory* amper.ped.muni.cz/jenik/letters/public/msg00138.html.

[1] In the poster, some imaging photometry examples from the London conference are shown; I have made available all examples including both photopic and metabolic-efficient photometry just now, see amper.ped.muni.cz/light/luminance/london.

2.3 LPS filtering

There is a wrong, but widespread opinion that light of several kinds of HID lamps can be simply filtered out, to get the starry skies back easily. At first I replied that it is not the case even for LPS, amper.ped.muni.cz/jenik/letters/public/msg00156.html – then I searched further and found that, in principle, it is possible for LPS, being just a bit expensive, amper.ped.muni.cz/jenik/letters/public/msg00158.html (the technology of "didymium glasses" had been developed for people who treat glass with a flame).

As a fifth measure (0 cd/klm horizontally and above, minimum needed amounts of light on target areas, as little as possible elsewhere, using LPS only) it may become a reasonable help, when paid for by the polluters. A recommendation stemming out of that is *[CFDS] good LPS use should be revived* amper.ped.muni.cz/jenik/letters/public/msg00159.html

2.4 MLO

The draft of the Model Outdoor Lighting Ordinance, as submitted to public review by the IDA in 2004, appeared to be a bad one for the of protection and restoration of healthy and pleasant night environment. Our final position is available as *MLO2004.1_j.htm* amper.ped.muni.cz/jenik/light/drafts/MLO2004.1_j.htm

Many discussions preceded this statement, some letters being published:

- *Fix the MLO (fwd) (and filters at last)* amper.ped.muni.cz/jenik/letters/public/msg00160.html
- *[Darksky]Shielding nonsense* amper.ped.muni.cz/darksky/2004/000079.html
- *[magnitude6] Re: USA Model Lighting Code (fwd)* amper.ped.muni.cz/jenik/letters/public/msg00161.html
- *MLO V.2004.1, position of Italian orgs.* amper.ped.muni.cz/jenik/letters/public/msg00163.html
- *[fixthemlo] Amounts of light* amper.ped.muni.cz/jenik/letters/public/msg00171.html

2.5 Luminaire photometry tool

I have supplemented my command-line programme ies2tab by a possibility to convert luminaire photometric data from ies to eulumdat format (as far as I know, this became the only standalone and free convertor). The programme and scripts easing its use for batch processing of thousand of files is within amper.ped.muni.cz/light/ies2. The original purpose of the programme was getting cutoff categories from photometry files and computing the (obsolete) increase of skyglow due to direct emissions over horizontal directions.

2.6 Monitoring night sky by PV plants

An idea coming from Thomas Posch has been published: any photovoltaic plant can become a sensitive device for measuring night sky brightness, when it ceases to produce power after sunset, see amper.ped.muni.cz/jenik/letters/radiometry/msg00014.html. (A student of Masaryk University in Brno, Tomáš Miléř began to work on the issue just at the end of 2005.)

2.7 Legislation

Our legislation efforts produced at least one useful output, a short English text containing the minimum needed set of rules to be implemented together. We have attempted (in vain) to put it on agenda of the European IDA Symposium in Paris, see a letter from July 1, *[Darksky]Endorsing an EU legislation* `amper.ped.muni.cz/darksky/2004/000065.html`. An updated version has been made then in November (that version is on our web now).

Recommendations for our draft came from just a couple of experts (Fabio Falchi, Pierantonio Cinzano, Cliff Haas – I think he insisted we should not say "downward", giving a wrong impression that the law demands "steep down", we obeyed it later).

3 2005

3.1 Legislation

The former deputy Stanislav Fischer returned to the House of Representatives – that one, who proposed the inclusion of protection of the air from outdoor lighting into the bill of the Czech Clean Air Act, and who achieved that first small step in 2001/2002 (became an IDA member afterwards).

The bill for an amendment of the Act came to the House early 2005, leaving it unchanged (i.e., minimised) as regards night atmosphere protection. We have agreed that he will submit a proposal for its change. He did so, with a text not much differing from the English version from November 2004.

No campaigning at all took place, we just wrote to a couple of Representatives, and Fischer spoke shortly at the plenary session. Surprisingly, a non-negligible amount of MPs (almost one third of those present) supported his proposal, across the parties. The Minister of Environment took a neutral position (a step forward against 2003).

For the Minister and those Reps who cared, we had two new arguments, not available in 2003: the huge report on night environment, prepared for the ministry in 2004, `amper.ped.muni.cz/noc/`, and a translation of the 2004 amendment of the 2000 Lombardy law – together with a synthetic current version of Lombardy legislation it is at `amper.ped.muni.cz/light/zakon_oo/2005/lombardie/`.

We are afraid that the Czech translation is the only one in the world, what is a bit a shame – the Lombardy legislation, together with the subsequent legislation of further provinces (five other before the end of 2005, more than 20 million inhabitants), has survived the test of the time, and remains to be the best template for all the world. (Let's remark that a notable new feature of the laws accepted in 2005 is the correct *definition* of light pollution: *alteration of the natural levels of light*. Outdoor lighting *is* polluting, what we try to achieve, is either minimising its most adverse consequences, or avoiding it altogether when possible.)

In August, we prepared a Czech bill with simpler wording, implementing some changes in the Lombardy legislation. Together with that which has been submitted in spring, it is within `amper.ped.muni.cz/light/zakon_oo/2005/` This bill has not been submitted yet, the House being overloaded and the MPs being busy with the future elections.

Its English analogy (with an added exemption for beamers with sources fainter than 1500 lm and lasers below 5 mW) is available within `amper.ped.muni.cz/light/law/Jan06/`, open to the international discussion. We shall submit the Czech version of this bill this year.

3.2 National Park at Night research

Already at the end of 2004, people from the oldest and largest National Park in the Czech Republic, Giant Mountains (Czech: Krkonoše, German: Riesengebirge; `www.krnap.cz/en/`), responsible for nature protection there, asked us if we could investigate the night aspect of *landscape character* there and its changes due to artificial lighting in general and ski slope lighting in particular.

We put together a team consisting of two architects (Jitka Brychtová, Josef Krause), experienced experts in landscape character assessments (just daytime ones, before this project) and me. During several stays in the Park in 2004/2005 winter, we have visited and documented many localities, views and circumstances. A comprehensive final report in Czech has been published in summer 2005, see `amper.ped.muni.cz/noc/krnap`.

Visual evaluation and imaging digital photometry were our main tools. Imaging photometry was supplemented occasionally by luxmeter measurements on the spot, to know some values instantly and to have some check values with which the imaging photometry could be compared later. The main instrument was a compact digital camera Nikon Coolpix 990, equipped with a fish-eye convertor FC E8 when needed. This set had been calibrated photometrically and the needed software developed in the same time (my programme raw2lum and an adaptation of a standard `dcraw` software). The software is free, available from `amper.ped.muni.cz/light/luminance`. (The last stage, compensation for vignetting – light loss – far from the centre of image, has been solved too already, but is yet to be implemented to the report results – ignoring it means, that the amounts of light are partly a bit larger than the report says).

One result had to be expected: clear night moonless sky in the National Park is at least twice more luminous than a natural sky. It concerns even the ridges of the highest Czech mountains. Milky Way is visible, but not at all fascinating, due to the common sky luminance of $0.5\,\mathrm{cd/m^2}$. Strong illumination of just two ski slopes (Hromovka and Javor), when operating, causes the clear sky luminance to increase to about twice higher levels, to one millicandela per square metre – or "one millinit" as it can be called as well – or even to several millinits, in direction toward these major sources of pollution. These are already city-like values (like those measured in Brno, second-largest in Czechia, after Prague), rather shocking when we consider they are encountered in a mountain National Park.

Another result was even more serious. Relative level of pollution of the night environment increases by orders of magnitude, when there is a cloud layer over the mountains. We summarised the results in the following table, using a more common quantity, namely the illuminance of the ground, concerning winter conditions with a snow-covered landscape:

Illuminance of the Giant Mountains landscape / 1 mlx				
Environment	Full Moon		Moonless night sky	
	cloudless	overcast	cloudless	overcast
Natural	100	1 to 10	1	0.01 to 0.1
With artificial lighting, without ski slope lighting			3 to 100	10 to 100
Including ski slope lighting			6 to 300	20 to 300

In another words, the *night light levels at this National Park are commonly 100× to 10000× higher than the (desirable, for protected nature) natural ones*, in case of overcast

weather. This is no minor pollution! All nights, when light is recycled between snow and thick clouds, there is like if a constant waxing Moon in the Park (just the shadows are missing), instead of a pitch-black night, proper to the Nature.

The very high light levels are not the only problem. *The landscape character changes tremendously from day to night, as the lights themselves become dominant.* Every minor daytime-visible detail (as the colour of roofs, shape of windows) is considered thoroughly during any building permission procedure, but the night appearance of built environment has been completely neglected. Strong visible lamps over the ski slopes are far more disturbing than the lit snow itself.

This was not unexpected, but two findings were. In many cases, the luminous (strongly illuminated and a bit dispersing) air in the valleys prevents the landscape behind it to be visible at night, almost zeroing its contrasts. And some cases, illuminated mountains slopes reach the luminance of the sky behind them, and the ridge outline ceases to be discernible. *When the illumination the ski slope Javor*[2] *is switched on, the second largest Czech mountain, "Studniční hora" (Brunnberg) disappears...* Just the highest one in Czechia, Sněžka (Schneekoppe) remains slightly visible, being farther from the lights and partly screened by the forest. Even David Copperfield could not achieve more...

Quite probably, our research was the first one concerning many aspects of night environment in any National Park worldwide... The other ones, like those in the US, concerned mostly just clear sky luminance.

3.3 Tolerable ski slope lighting

Our report investigated also a possibility how ski slopes could be illuminated with minimised consequences for the environment. Apart from an evident need to emit almost no light outside the target strip of the slope (full shielding alone is not sufficient here; no lights should be visible to people standing even at the bottom of the valley), the total amount of emitted light is to be small. This necessity is much more stringent for white snow than for a asphalt road, because of albedo and because of the usual large width of ski slopes.

Our recommendation, which ensures some compatibility with nature protection, and enables sustainable ski lighting in this Park, is using no more than 0.5 lx, and keeping each illuminated area below 5 hectars. The 25 klm emissions needed for the task would not affect areas which are farther then 5 km from the slope (and where the slope is not directly visible) too much, the increase of light levels would be equivalent of illumination by Venus at most. In this way, a slope which is more than 5 km away from any First Zone of the Park (First Zones are areas, where anthropogenic influence is to be excluded), does not endanger it by its illumination alone. A limited amount of such illuminated slopes can exist even in the future, provided that another illumination (streets, hotels) will be brought to minimum in extent and in intensity.

Half-a-lux illumination, when properly directed, is sufficient for skiing in the same time. This knowledge is based on the experience with skiing by the full moon (quarter-a-lux at most), on the (much appreciated) letter by Nancy Clanton (see `amper.ped.muni.cz/jenik/letters/ski`), on the theoretical considerations about visual performance at different scene luminances, and on the minimum spot (not average) luminance levels recommended for roads. And, moreover, we found a part of one ski slope, which is not

[2] in one of the two main tourist centres in the Park, Pec pod Sněžkou (Petzer)

avoided by skiers, and which has some 0.4 lx illuminance (even if visibility is far from being ideal there, due to a glare from a lamp lower on the slope).

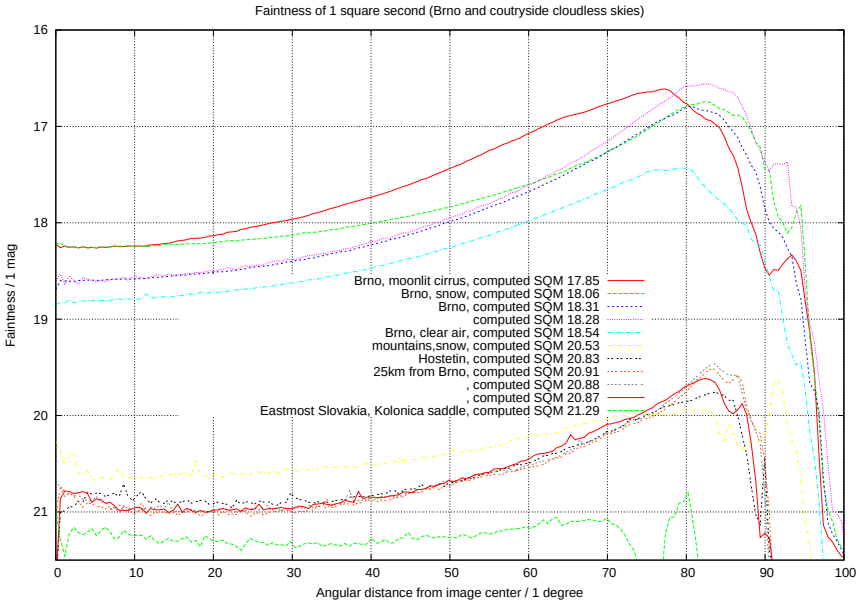
3.4 SQM issues

We have solved the task of measuring luminance of all sky using a fish-eye camera. However, costly equipment (one thousand USD at least) and subsequent computer processing is needed. In 2005, an new possibility emerged: a simple and cheap measuring instrument (like if an extremely sensitive luxmeter) has been developed, called Sky Quality Meter, see `unihedron.com` (Quantity would me a more descriptive noun, as the reproducibility of measurements is better than ten per cent, or 0.1 mag). To the emerging discussion, I have written several series of contributions.

The first one had been on the correct transformation of readings to expressing luminances in common units – cd/m^2 – and on the possibility to call them by the non-SI name *nits* (fractional units, as millinits, are even more useful). This line started as *Night Sky Quality Meter*, `amper.ped.muni.cz/jenik/letters/radiometry/msg00009.html` and continues with further four items in the archive, calling cd/m^2 "nit" when needed, Re: calling cd/m^2 "nit" when needed, Conversion from "mg/arcsec$\hat{2}$" to cd/m^2, Re: Conversion from "mg/arcsec$\hat{2}$" to cd/m^2.

Further series stressed the necessity to know "zenith extinction" and offered the ways to measure it with SQM or estimate visually: `amper.ped.muni.cz/jenik/letters/public/msg00188.html`, 191.html 192.html 193.html

In autumn, I evaluated several types of luminance – zenith distance dependencies, from fish-eye images taken in Brno and elsewhere, including one remote, just little polluted location. There had been a slight problem with existing vignetting of the images (underestimating luminance far from zenith), this has been corrected later (and implemented into `raw2lum`). The resulting data are within `amper.ped.muni.cz/light/luminance/radial`, the very image comparing different sites and giving readings assumed for the SQM tested by Pierantonio Cinzano is reproduced here:



(Early 2006, a contribution *uses of SQM and how to re-calibrate* `amper.ped.muni.cz/jenik/letters/radiometry/msg00015.html` opened a thread on the angular sensitivity. It appears that the instruments differ not negligibly. Fortunately, there is an easy possibility to calibrate them for narrow-cone or even point-source measurements.)

3.5 Skyglow from the lit ground

An old argument of polluters about shielding is that strict requirements are obsolete – their "researchers" claim most of skyglow is due to the lit ground, not due to nowadays "excellent" luminaires.

We proposed that even if the question is solved long ago by computation (over 0.5 cd/klm horizontally and above becomes too much), for those who need to see to believe, there is a possibility to measure the influence of the ground directly, comparing snow-covered and snowless conditions. The idea and some evidence is available within *exact answer on shielding and skyglow* `amper.ped.muni.cz/jenik/letters/public/msg00130.html` and subsequent 131.html and 174.html.

3.6 Education

Several English-written contributions concern amounts of light and shielding. Some of the included info may have been published for the first time, but I would not call it research.

One of them concerns *Traffic Sign Board and Lighting* `amper.ped.muni.cz/jenik/letters/public/msg00197.html`.

The other two try to summarise the current knowledge of the links between outdoor lighting and cancer, *Re: Light at Night and Cancer* `amper.ped.muni.cz/jenik/letters/public/msg00194.html` and a more recent *Re: Light at night-cancer risk in humans verified* `amper.ped.muni.cz/jenik/letters/public/msg00204.html`.

In 2005, there appeared new publications which should help to wipe out the most damaging myth about lighting. We therefore continued to promote the knowledge of real science on crime-light relation (this time by Paul Marchant), making available the following commentary: `amper.ped.muni.cz/jenik/letters/public/msg00181.html`

Reminding people that the theory of skyglow exists (and says that full shielding is the most important single measure), seems to be a never-ending task. I wrote *Three reasons why full shielding is indispensable* – see "why_fs" within `amper.ped.muni.cz/light/shielding` directory – and continued with three other letters *Re: fco and uplight* `amper.ped.muni.cz/jenik/letters/public/msg00209.html`, 210.html and skyglow from various uplights (211.html). The idea is, in short: *light emitted almost horizontally is much more harmful* than light dispersed from the terrain. A simple sum of these two light fluxes ("amount of uplight") is no quantity, from which the clear sky luminance (skyglow) could be computed (if direct emissions are not zero).

3.6.1 In Czech

A nice project began late 2005: publishing night photos with commentaries within an electronic astronomy newsletter, `ian.cz`. Gradually, more people send in images and comments. We assume to send most alarming photos and findings to the corresponding municipalities.