

The phantom light effects in rear signalling lamp combinations of modern vehicles

*Report about an investigation,
which based on the work of*

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Report to GRE 60 and GTB 106 in Verona

Studies have shown that



- approximately **65 %** of all rear end accidents and
- approximately **50 %** of all crossroad accidents

could be avoided if the driver has **0,5 seconds more reaction time.**

[Enke]

Motivation

The clear recognition of the signals is very important!

Which situations have an influence to the detection of signal lamps?



Background

- Phantom light effects
- Survey to the current study for signaling lamps

Materials and Methods

- Results
- Conclusion
- Outlook



Phantom light effects

Phantom light signal:

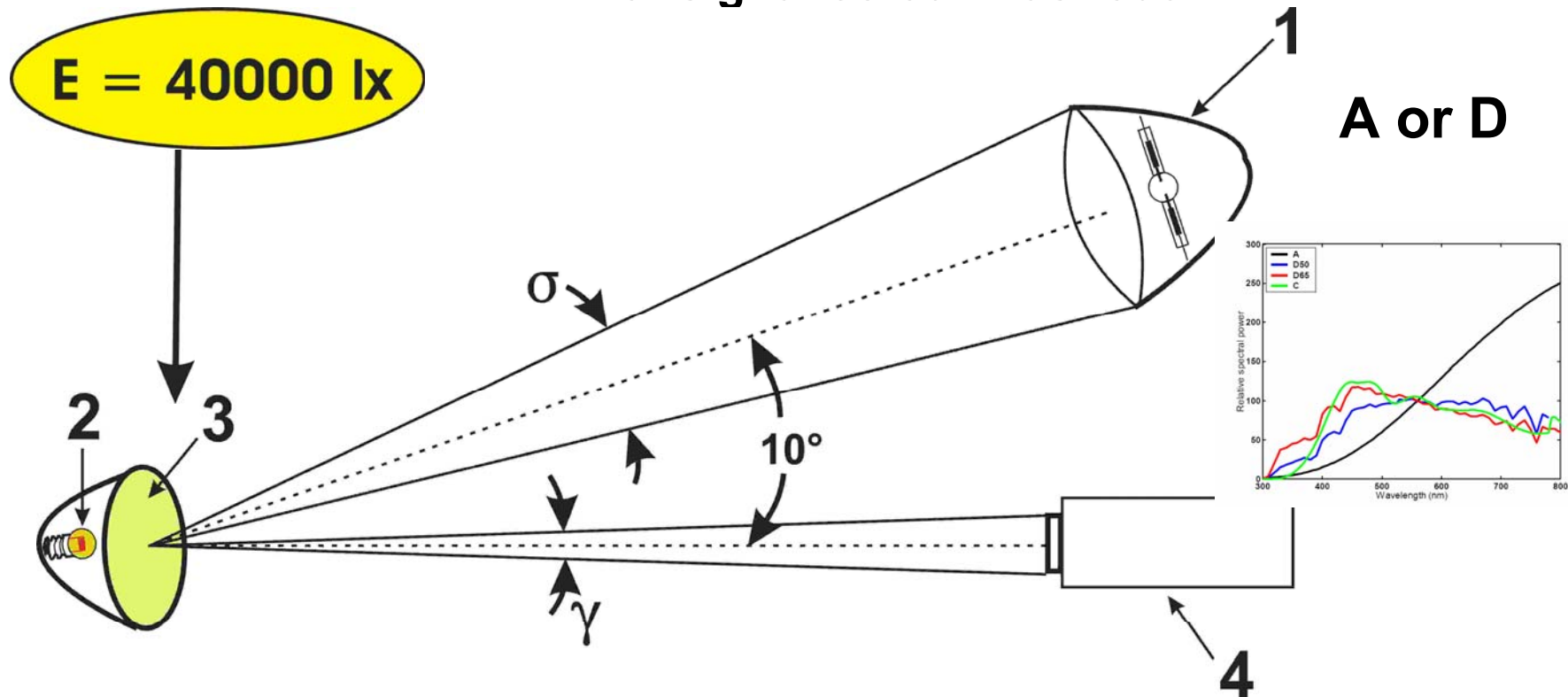
- A Signal could be recognised, but the signal is not switched on
- Affected by the reflexion of sunlight

Colour wash out effect:

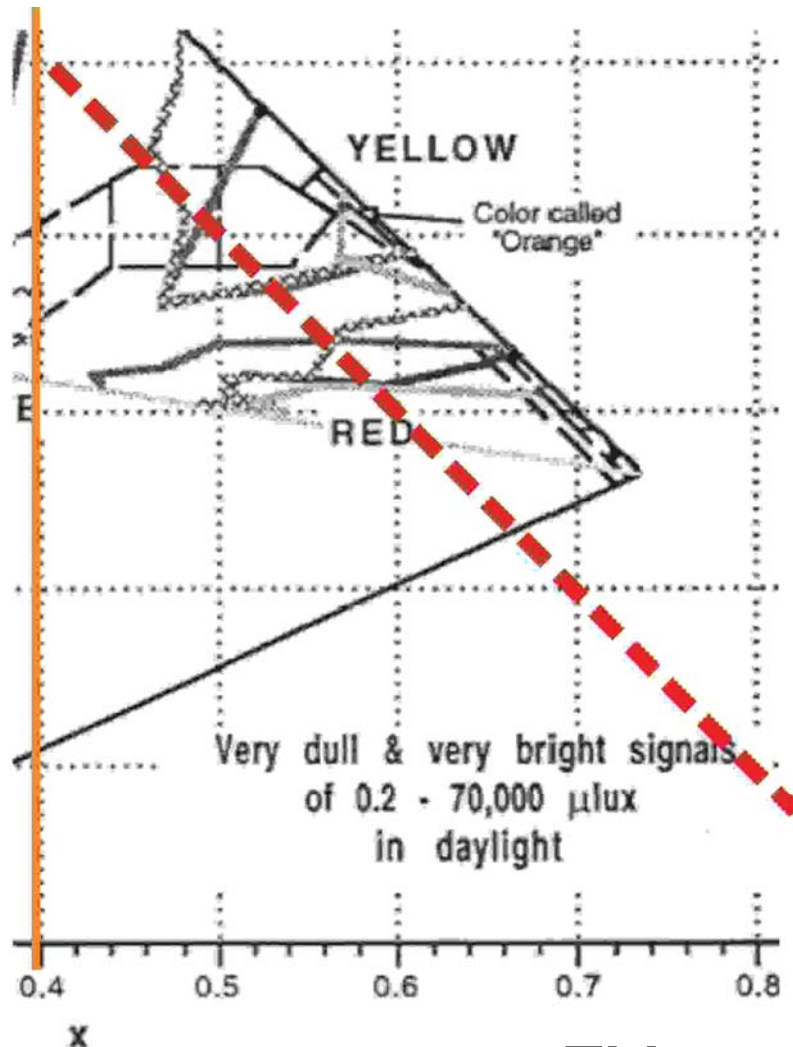
- strong desaturation of the signal colour
- reduced visibility

Typical standardised measurement arrangement

for signal colour washout



- 1 = test projector,
- 2 = light source of the test sample,
- 3 = Lens of the test sample,
- 4 = photometer head, (γ = photometer head aperture, σ = source aperture)



Colour Wash Out:

Relatively big deviations results from the first colour wash out investigation:

Where should be the limits?

No direct correlation of these lamps to the time delay in recognition and colour shift could be determined!

This way seems to be not successful!

2 Materials and Methods

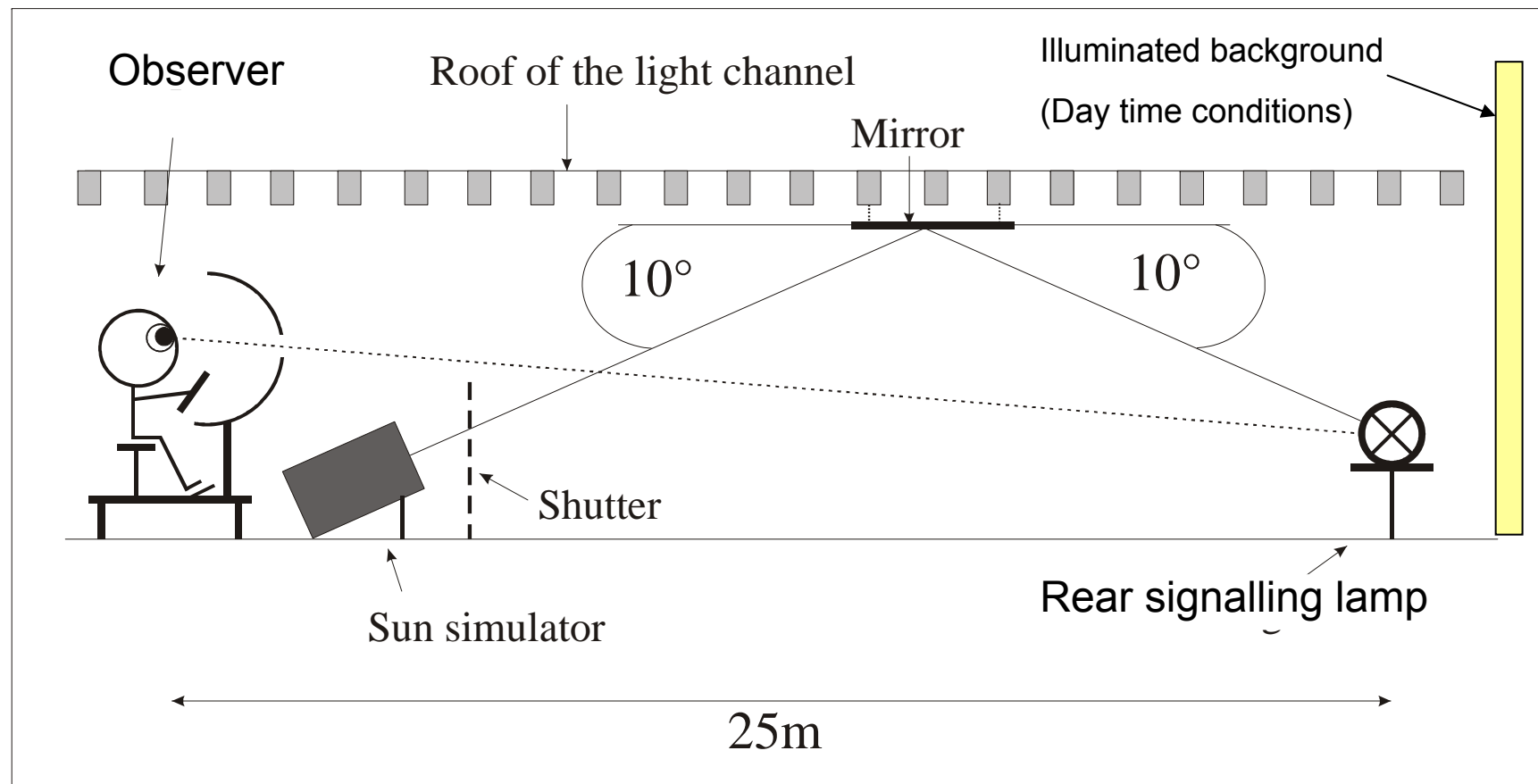
Next step: Investigation on contrast:

Experiment set-up

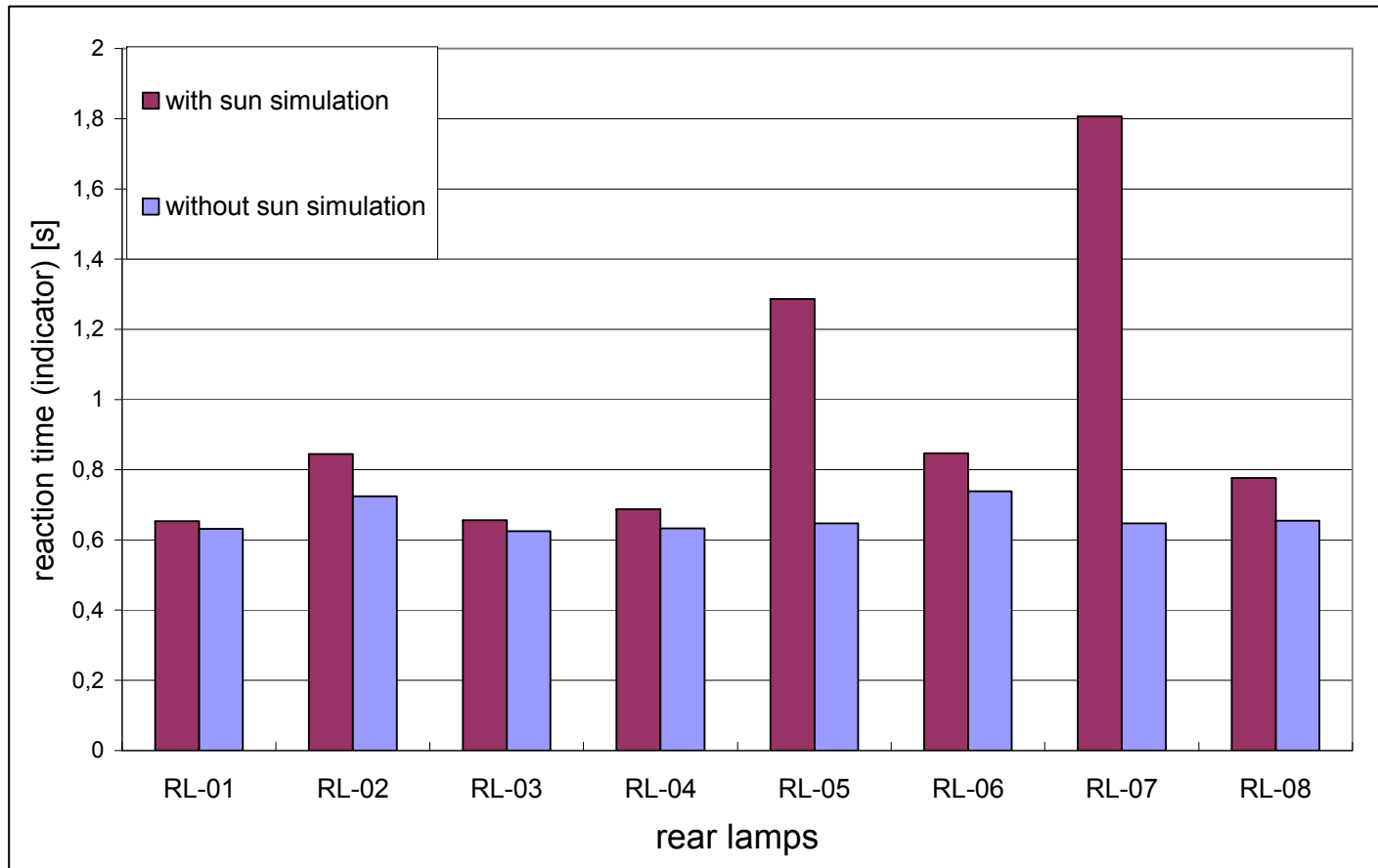
- Signalling lights (dir. indicator and stop)
- Luminance camera
- Sun simulation



Principle Test set-up for measuring the reaction time:

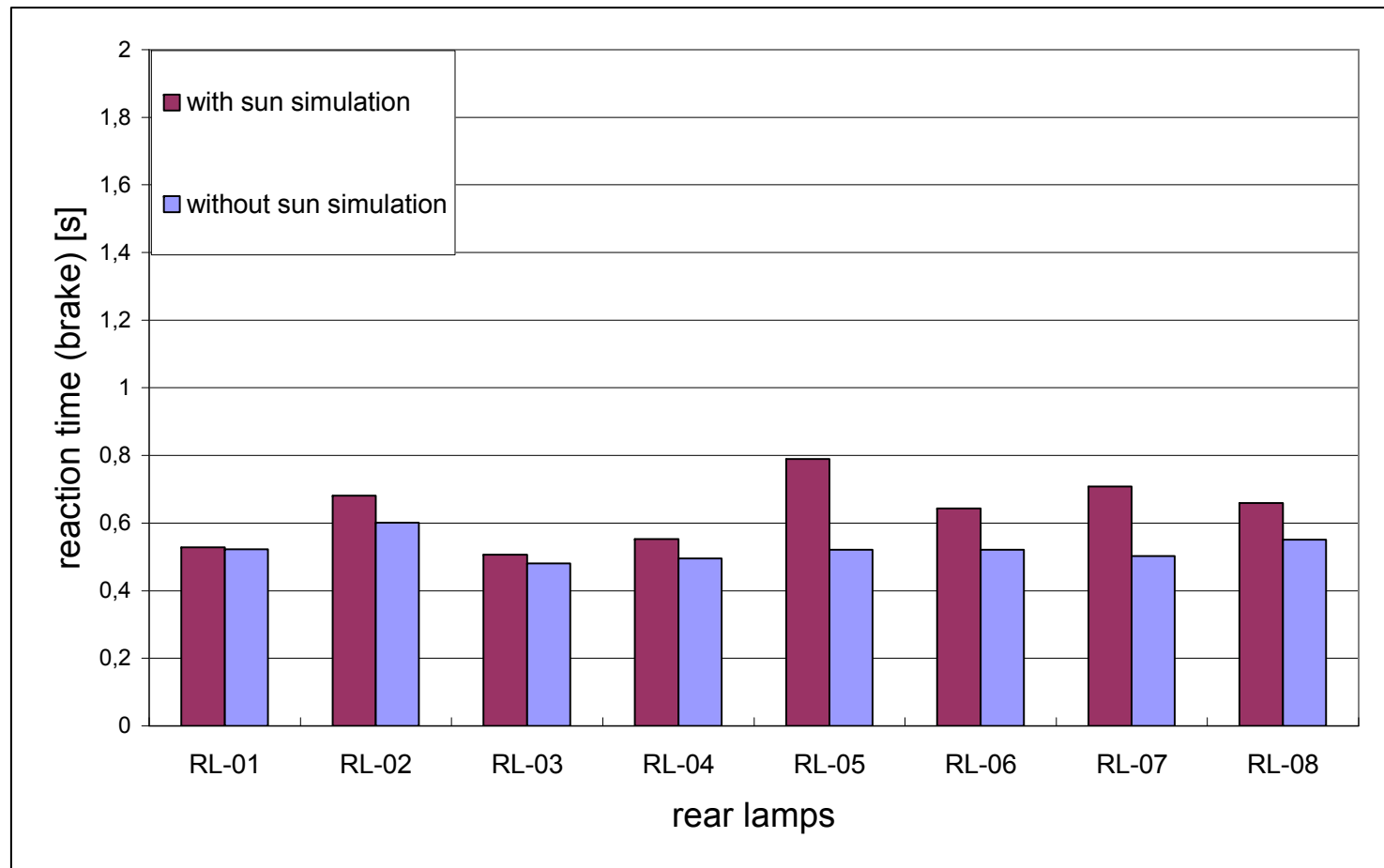


Some results: signal „direction indicator” (not complete)



Reaction times (Indicator) of eight rear end light with and without sun simulation

Some results: signal "stop" (not complete)



Reaction times (Brake light) of eight rear end light with and without sun simulation

Result:

Different sensitivities to external light.

Increased reaction times of some signalling lamps can be considered as crucial!

A relative high number of signalling lamps show no negative effect!

Measurement method:

Precondition

Evaluation only for signal area and close to the signal

Possible method (first approach)

Generation of a mask from the signal area

- Pixels with luminance higher than $11\,000\text{ cd/m}^2 = \mathbf{1}$
- Pixels with lower luminance $= \mathbf{0}$

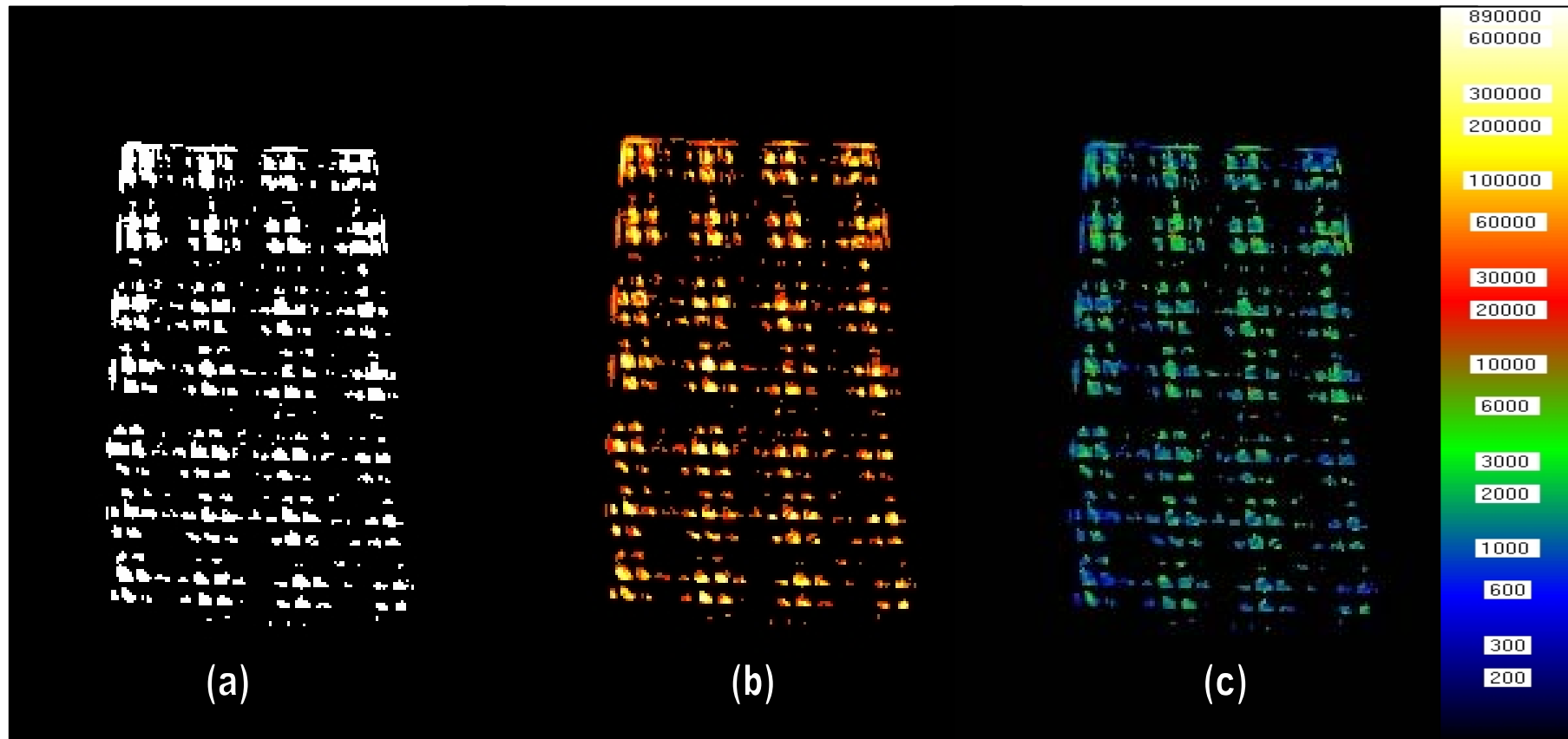
$$F_{Ph} = \frac{L}{L_{Ph}}$$

L Mean luminance of the signal

L_{Ph} Mean luminance of phantom by irradiation with sun light and switched off signal

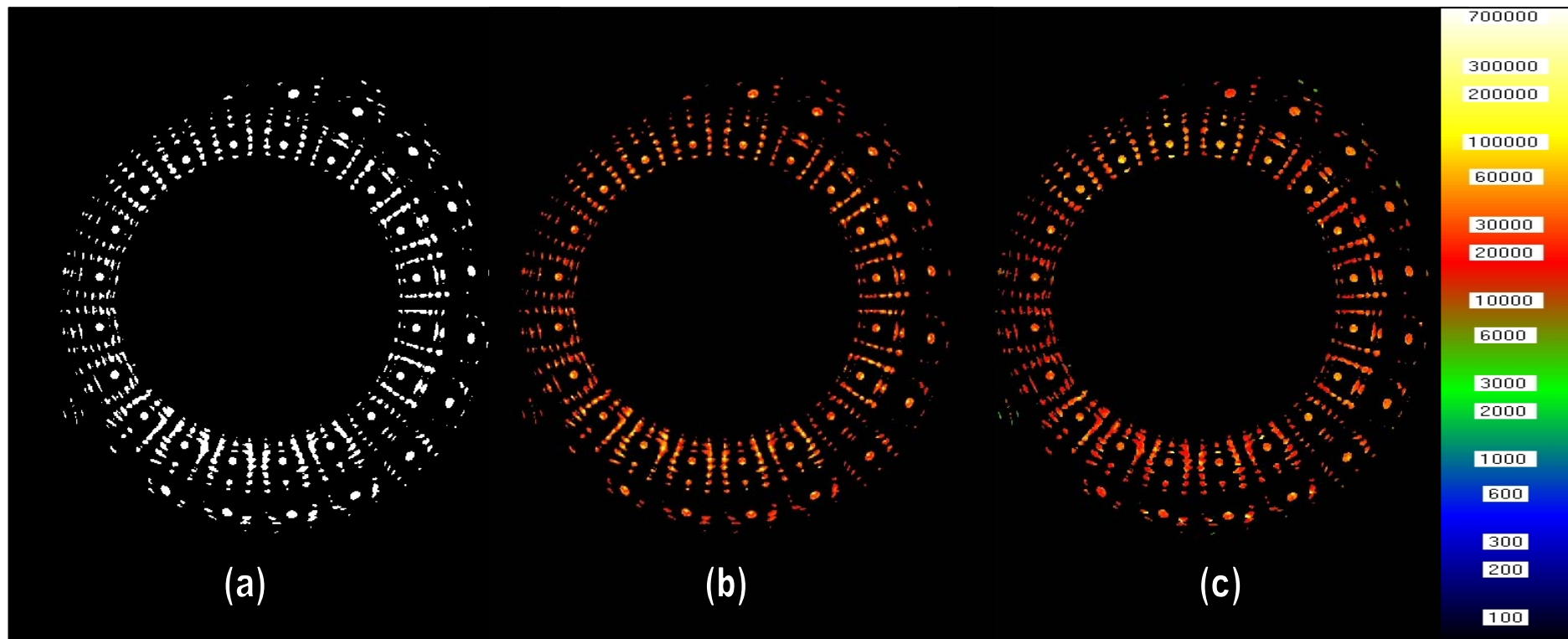
F_{Ph} Minimum value of the quotient from the luminance of the signal L to the luminance of the phantom light L_{Ph}

Signal turn indicator



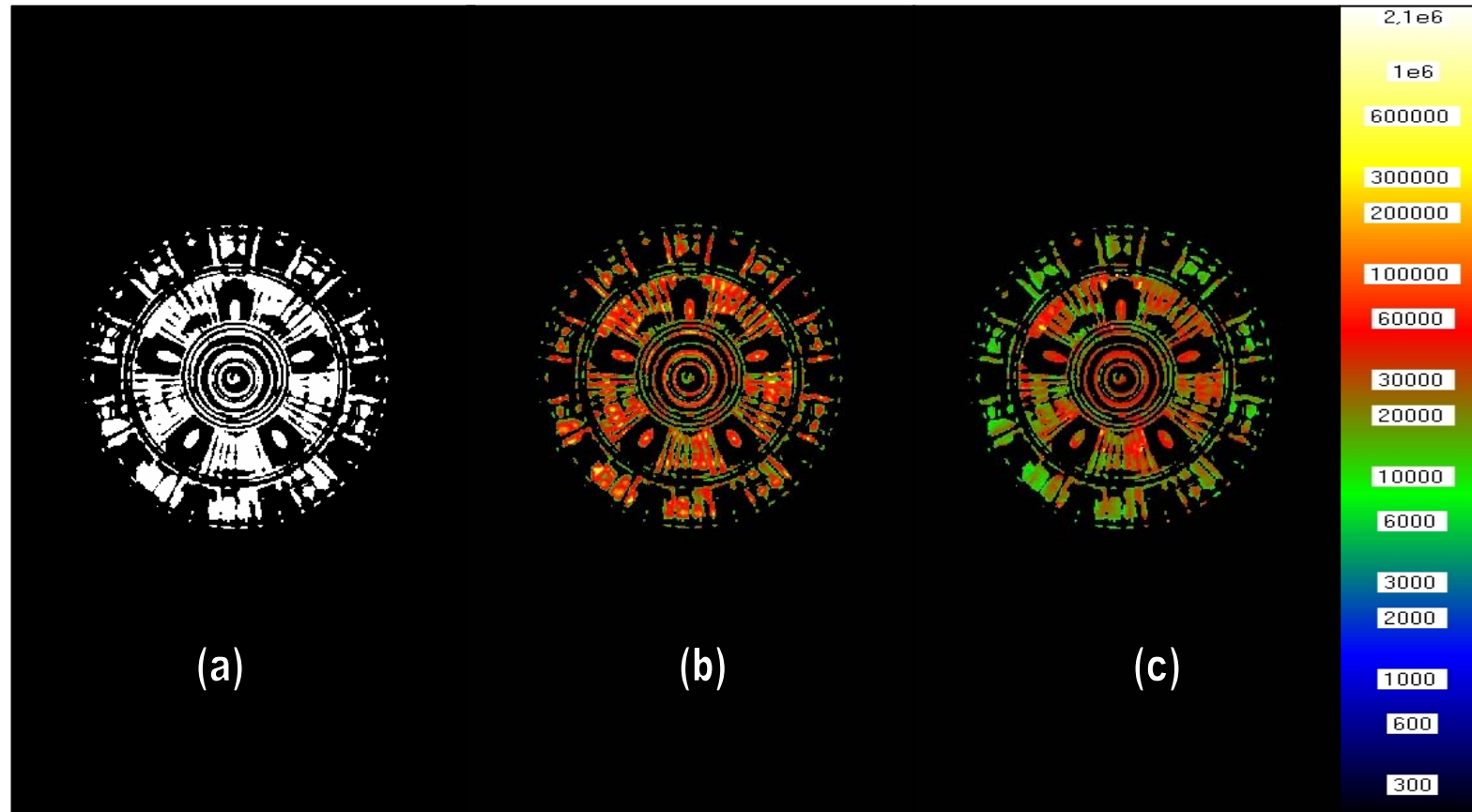
Luminance pictures (signal indicator) (a) mask, (b) luminance of signal, (c) luminance of phantom

Signal "direction indicator"



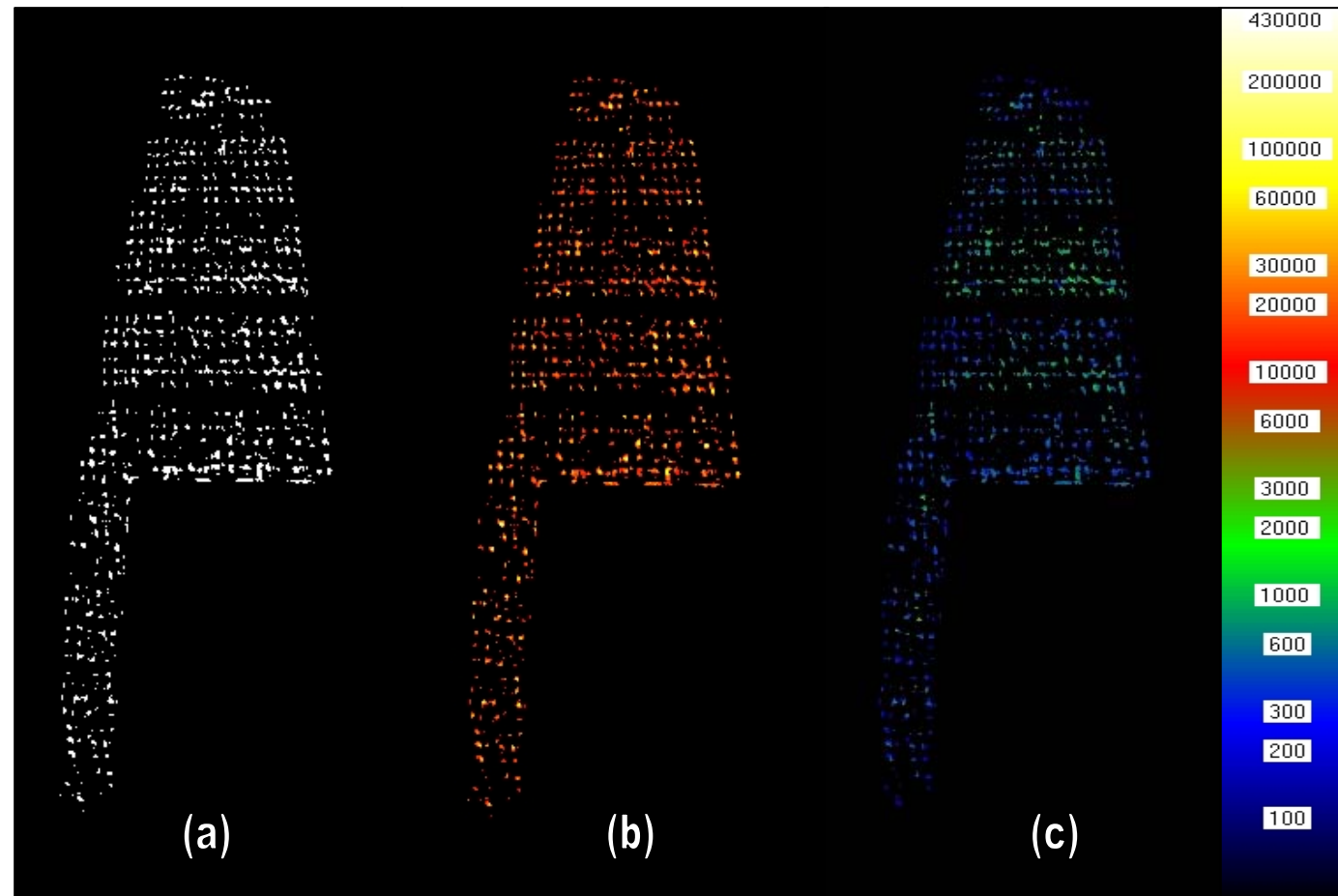
Luminance pictures (direction indicator) (a) mask, (b) luminance of signal, (c) luminance of phantom

Signal "Stop"



Luminance pictures (stop lamp) , (a) mask, (b) luminance of signal, (c) luminance of phantom

Signal brake



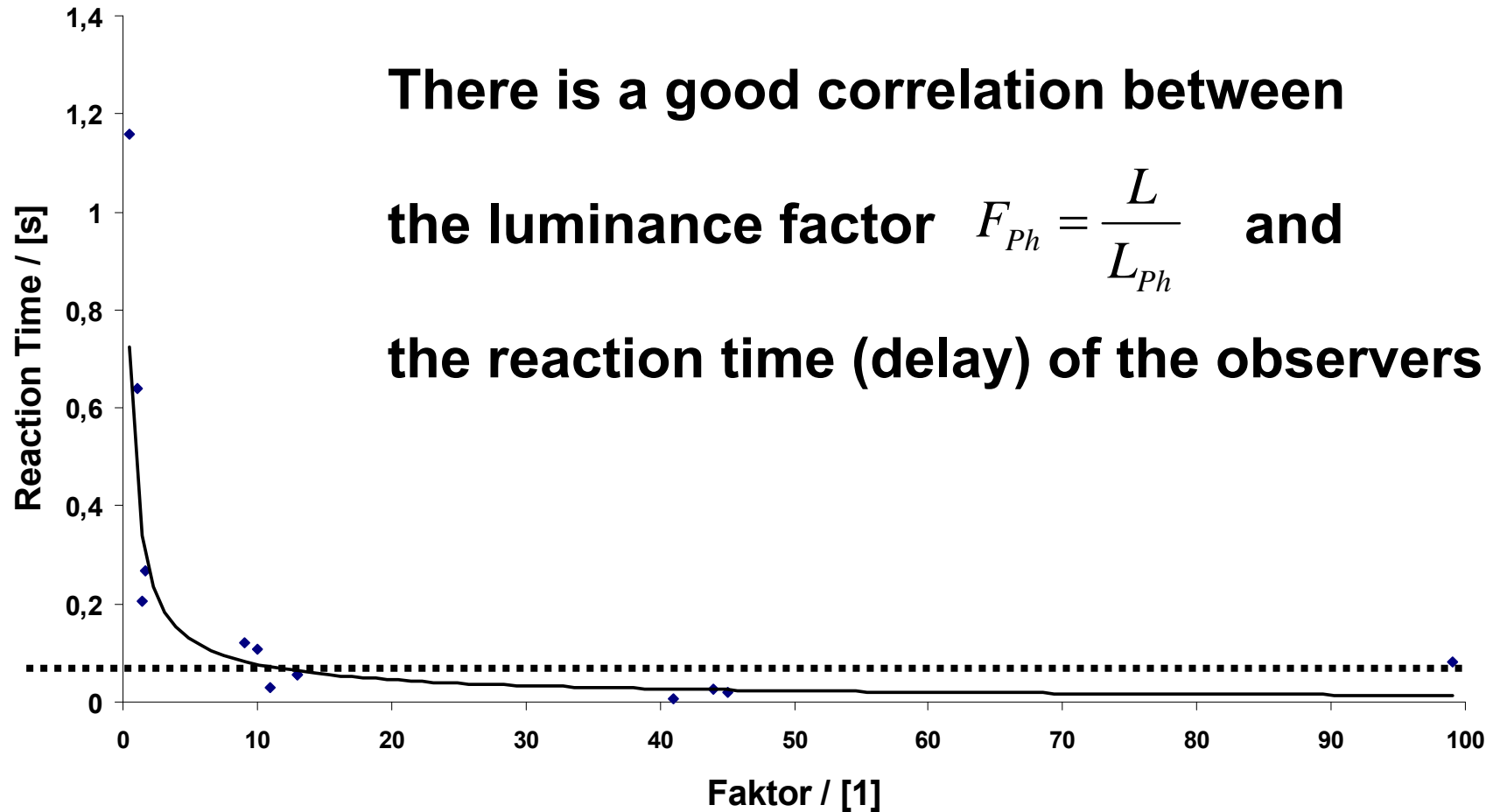
Luminance pictures (stop lamp) (a) mask, (b) luminance of signal, (c) luminance of phantom

Table 1. Results signal (direction indicator)

Test sample	<i>"RL-05"</i>	<i>"RL-01"</i>
L [cd/m ²]	36311	92207
L_{Ph} [cd/m ²]	32288	2045
F_{Ph}	1,1	45

Table 2. Results signal (stop)

Test sample	<i>"RL-05"</i>	<i>"RL-01"</i>
L [cd/m ²]	50095	23563
L_{Ph} [cd/m ²]	29444	575
F_{Ph}	1,7	41



Conclusion

Determined factors F_{Ph} in a wide range

→ Different sensitivities to external light

Factor F_{Ph} is a good base to evaluate the signal at daylight conditions

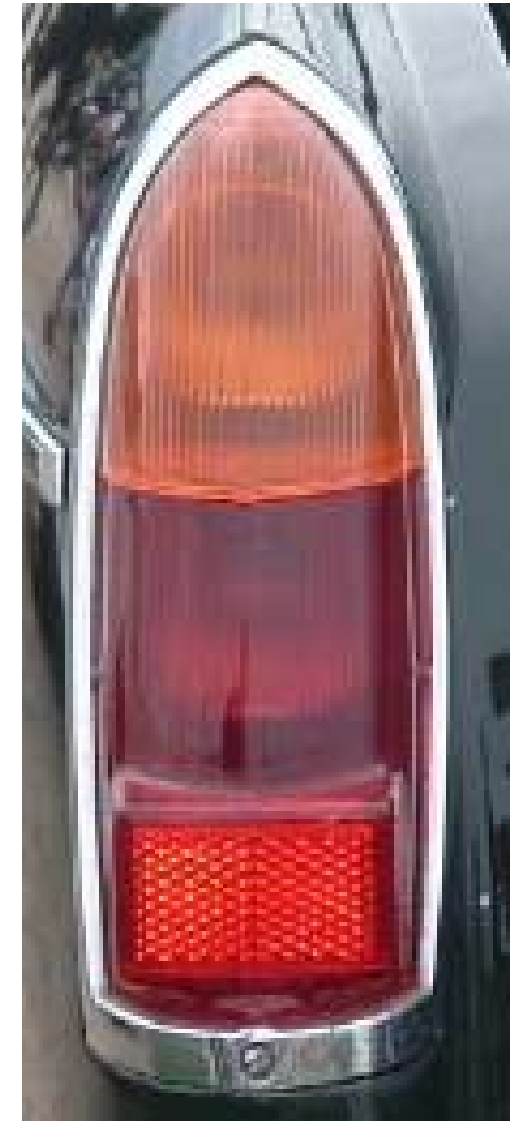
Possibility to improve traffic safety



Next Tasks:

Analysis of

- Data from more signalling lamps
- Measurement method
- Luminance method
 - with camera
 - with classic luminance meter
 - with other means ...
- scaling of the surface illuminance



Final:

Matching of the test method(s) by the results of the observers.

The goal:

**To develop a good reproducible test procedure,
suitable to be the base for proposals
to amend the relevant ECE regulations.**

The work will be continued

Thank you for your attention !

Literature:

Enke, K., "Possibilities for Improving Safety within the Driver Vehicle Environment Loop," 7th Int. Techni-cal Conf. On Experimental Safety Vehicle, Paris (1979)

Haar, G., „Fremdlichtempfindlichkeit bei Kraftfahrzeugheckleuchten – Möglichkeiten zur Minderung,“ Au-tomobiltechnische Zeitschrift (ATZ) 82 (1980)

Manz, K., "Colour Washout Test Procedure for Signalling Lamps," ISAL 2005 Symposium, Darmstadt University of Technology (2005)

Lora Warshawsky-Livine, David Shinar, "Effects of uncertainty, transmission type, driver age and gender on break reaction and movement time," Journal of safety and research, Chicago (2002)

Eckert, M., „Lichttechnik und optische Wahrnehmungssicherheit im Straßenverkehr,“ Verlag Technik GmbH, Berlin München, ISBN 3-341-01072-6 (1993)

DIN EN 12368:2006, "Anlagen zur Verkehrssteuerung – Signalleuchten"

Hahn, N., "The phantom light effects in modern car rear light combinations," ISAL 2007 Symposium, Darmstadt University of Technology (2007)

Armbruster, D., "Optimierung der visuellen Informationsübermittlung durch adaptive Kraftfahrzeugsig-nalleuchten,“ Herbert Utz Verlag, Darmstadt, ISBN 3-8316-0016-3 (2001)

Franco Marcori. LED in Rear Lamps, Performance and Styling. In Prof. Dr.-Ing. H. F. Schlaak, Editor, *ISAL - International Symposium on Automotive Lighting*, Band 11, Seiten 426–429, Darmstadt, 2005. Herbert Utz Verlag GmbH.

Karl Manz, Karsten Klinger, und Dieter Kooß. Possible Modern Concepts to Determine Lighting Areas or Distances between Lighting Functions. In Tran Quoc Khanh, Editor, *ISAL - International Symposium on Automotive Lighting*, Band 12, Seiten 370–371, Darmstadt, 2007. Herbert Utz Verlag GmbH.

Norbert Hahn, Karsten Klinger, Karl Manz, und Uli Lemmer. The phantom light effects in modern car rear light combinations. In *ISAL - International Symposium on Automotive Lighting*, Darmstadt, 2007. Herbert Utz Verlag GmbH.

Paul L. Olson. *Evaluation of a New LED High-Mounted Stop Lamp*. Motor Vehicle Lighting, SAE PT-60. Society of Automotive Engineers, Inc, 1996, ISBN 1-56091-753-9.

Joachim Ripperger. *Lichttechnische Anforderungen an Schluß- und Bremsleuchten für Kraftfahrzeuge*. Herbert Utz Verlag, 2001, ISBN 3-89675-818-7.

Joachim Ripperger. *Luminance: the Future Photometric for Rear- and Brake-lights*.

PAL - Proceedings of Progress in Automobile Lighting. Herbert Utz Verlag GmbH, Darmstadt, 2001, ISBN 3-89675-971-X.

M. Sivak, M. J. Flannagan, S. Kojima, und E. C. Traube. *The Influence of Sun Loading on the Visibility of clear-lens Turn Signals*, Band UMTRI-98-2. University of Michigan- Transportation Research Institute, 1998.

M. Sivak, B. Schoettle, M. J. Flannagan, und T. Minoda. Effectiveness of clear-lens turn signals in direct sunlight. UMTRI-2005-19. UMTRI-98926, University of Michigan- Transportation Research Institute, Human Factors Division, 2005.

Bildaflösende Leuchtdichtemessung mit Leuchtdichtemeßkameras LMK96/98 (Videoanalysatoren

Norbert Hahn, Karsten Klinger, Karl Manz, und Uli Lemmer. The phantom light effects in modern car rear light combinations - Untersuchung des Einflusses des Phantomlichteffektes auf die Erkennbarkeit von Fahrzeug-Ruckleuchten. In *Lux Junior 2007*, Ilmenau, Dörnfeld, 2007.

Andreas Kaltenbach. Daylight simulation for the evaluation of rear lamps. In *ISAL / International Symposium on Automotive Lighting*, Darmstadt, 2007. Herbert Utz Verlag GmbH.

Andreas Kaltenbach. Daylight simulation for the evaluation of rear lamps. In *Lux Junior 2007*, Ilmenau, Dörnfeld, 2007. Technische Universität Ilmenau.

Andreas Kaltenbach. Tageslichtsimulation zur Bewertung von Kraftfahrzeugleuchten.

In *Lux junior 2007 - Abstracts - 8. Forum für den lichttechnischen Nachwuchs*. Technische Universität Ilmenau und LiTG - Deutsche Lichttechnische Gesellschaft e.V., Ilmenau, 2007.